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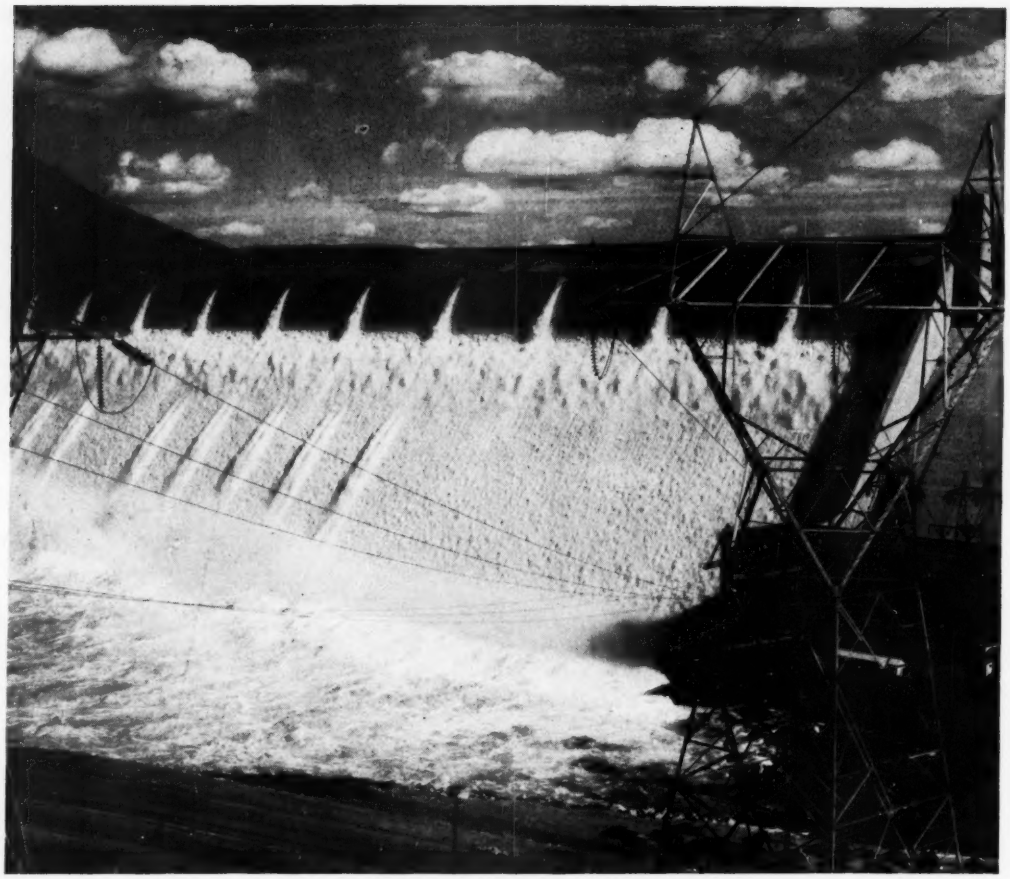

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COVER: At the Cornell Aeronautical Laboratory in Buffalo, skilled pilots perform full-scale flight tests in collaboration with the more fundamental research program of the Laboratory (see page 18).

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The Pursuit of Cosmic Rays

By PROFESSOR KENNETH I. GREISEN

ONE of the greatest remaining distinctions between the studies of nuclear physics and cosmic rays is that the nuclear physicists try to move the hills to Mahomet (see the mountains of iron in their laboratories), while the cosmic-ray physicists go like Mahomet to the hills, particularly in the summertime.

In each case, the objective is about the same—to have available a beam of high-energy particles, and do experiments on their behavior. The beams obtained by the two methods of approach are of course different in certain respects.

Nuclear vs. Cosmic Ray Physics

One of the fundamental differences is that each nuclear machine is specifically designed to produce a certain type of particle at a particular energy, so that there is comparatively little unknown about the beam itself. In cosmic rays, on the other hand, we must in general take whatever particles come along. There have been many surprises, in the study of the beam itself as well as in studying its interactions with matter. By such surprises unknown particles have been discovered, like the positron and the meson; new regions of particle energy (10^8 to 10^{17} electron-volts) have been opened for study; and unknown processes have been revealed, including pair formation (the creation of matter from radiation), decay of elementary particles, explosive nuclear disruptions, and meson production by energetic nucleons.

Most of our information has been gained, not through working always with a constant beam of particles, but by varying the quality of the beam. This the nuclear physicist does by turning a knob on the machine, or by letting in a different kind of gas, or if necessary by building another machine. The cosmic-ray physicist does it by travel.

The laboratory building at Echo Lake, Colorado, slightly more than two miles above sea level; taken shortly after completion of the building in 1948.

—Courtesy Ed Maker

Early Research Discussed

The importance of moving about in order to vary the quality and intensity of the cosmic rays has been clear since the early days of the very first investigations, when it was not yet known what the rays were or even that they originated outside the earth. The first studies were of the residual ionization current in electroscopes or electrometers, and it was soon concluded that a portion of the current was due to something that entered the vessels from outside. The small variations induced by moving the instrument around on the surface of the earth or down into caves and mines, and partciularly the decrease in current that was first observed when the instrument was carried aloft in a balloon, led to the erroneous conclusion that all the ionization was caused by radioactivity in the crust of the earth or in the atmosphere. The trouble was that the first balloon flights were not high enough. In 1912-1914, when V. F. Hess and W. Kolhörster made flights to a higher altitude, it was discovered that the drop in intensity with altitude soon ceased, and at greater elevations the ionization currents increased enormously, to a value 50 times the sea level current when the balloon had

Compressor rotor blades now in mass production for use in J-47 turbojets.

The laboratory and generator buildings atop Mt. Evans, Colorado, during the summer 1948. The trailers and the truck body housed experiments that could not fit into the crowded laboratory.

—Courtesy the author

reached 9000 meters.* The flights of Hess and Kolhörster have earned them widespread credit for being the discoverers of cosmic rays. These and the flights of Piccard have been the most daring experiments ever performed in cosmic rays, for they were made in manned balloons, without radio contact with the ground and with no means to control the direction of flight.

Millikan's Contribution

Millikan and his collaborators later found reasons to doubt the conclusions of the German investigators, and in 1924-1927 made many adventurous and elegant experiments in this country. They carried electrometers up mountains and aloft in airplanes and balloons. In deep, snow-fed lakes high in the mountains, they obtained ionization readings with instruments suspended at various depth under water. They compared readings under a given total weight of water and air with other readings at lower elevation, under the same total weight of air alone, and found them to be equivalent. This they concluded could only be true if the rays came from above the atmosphere. In deep gorges and narrow canyons, ionization readings were taken night and day--when the sun or the milky way was overhead and when it was shielded from the instruments by the earth. The intensity was found to be independent of the positions of the heavenly bodies, and Millikan therefore concluded that the rays did not come from the sun or the stars of our galaxy, but were truly cosmic in origin. Many people, on account of these researches, call Millikan the discoverer of cosmic rays; at any rate, he gave the name to them, and their cosmic origin has never since been in doubt.

Traveling Essential

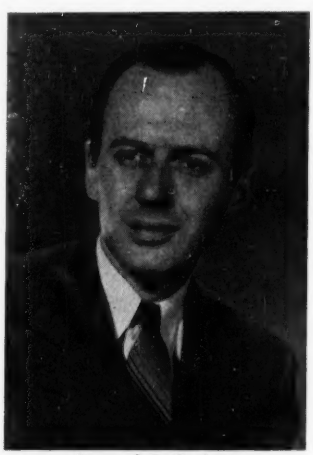
The feature of these early experiments that we wish to emphasize is how essential it was to move the detecting instruments to different locations, particularly as far up and down as possible. The variations of the cosmic rays are much more informative than their intensity in a single location.

Horizontal travel has also been effective. In 1927, Clay carried an ionization detector with him on a voyage from Holland to Java, and observed that at low altitudes the current was less than at higher latitudes. The best explanation was that the magnetic field of the earth impedes the arrival of cosmic rays. Therefore the cosmic rays not only must come from a distant region, outside the earth's magnetic field, but must largely consist in outer space of charged particles (rather than, for instance, high-energy gamma rays). In 1927-1928 this was a revolutionary conclusion, since no charged particles from radioactive sources had ever been observed with enough energy to penetrate as much as one percent of the atmosphere. Moreover, the energy which must be possessed by charged particles in order to cross the lines of force of the earth's field amounts to tens of billions of electron volts.

* It is indeed true that a portion of the sea-level background current is due to radioactivity in the crust of the earth, and this portion is not reduced by going down into a mine, and does decrease when one goes up in the air. At first, the decrease is greater than the increase in the cosmic ray intensity, but after about 1000 meters the cosmic ray effects predominate and increase with elevation.

THE AUTHOR

The author was born in Perth Amboy, New Jersey, in 1918, and first came to Cornell for graduate study in Physics in 1938, after graduating from Franklin and Marshall College ,Lancaster, Pa. He was interested in the subject of cosmic rays by Professor Bruno Rossi, one of the most outstanding men in the field, who was a member of our Physics Department from 1940 to 1944. Upon completion of his work in 1942 he was appointed Instructor in Physics, but in 1943 he went on leave of absence to help make atom-bombs at Los Alamos, New Mexico. He is married and has two young children; his wife is the former Elizabeth Chase, who received her Ph.D. in bacteriology at Cornell in 1942. Since 1946 he has been back at Cornell, teaching



Kenneth I. Greisen

Physics and directing research in cosmic rays.

Simultaneous horizontal and vertical displacements have proved to be necessary in order to tell the whole story of the earth's magnetic effect on the approaching cosmic rays, including the ones that are unable to penetrate the atmosphere. Thus, Millikan and collaborators sent balloons aloft to nearly the top of the atmosphere from stations at various latitudes in India, South America, Mexico, the United States and Canada. They found that whereas the sea-level latitude effect is only about 10 percent, the difference near the top of the atmosphere between the intensity at the magnetic equator and that near the poles is a factor of four. They also discovered that some other influence prevents particles of less than about two billion electron volts from approaching the earth near the poles.†

Studied at Extremes

Some study of the penetrating power of cosmic rays has been carried out by placing lead above the detecting apparatus, but it requires a meter of lead to equal, in weight per unit area, the thickness of the earth's atmosphere. So many of the rays are capable of further penetration, that it was necessary to use a really heavy absorber, of which the only one conveniently at hand is the earth. In the 1930's, Ehmert, Clay and Van Gemert, Volney Wilson and others took recording instruments to great depths under water or in deep mines. The greatest depth attained has been in Japan (1940-1945), where Nishina and Miyazaki recorded cosmic rays at a depth equivalent to 3000 meters of water, or 300 atmospheres. The energy required for a charged cosmic ray to reach this depth is 10^{12} electron volts (1.6 ergs), and the number of rays observed there is less by a factor 10^{8} than the number at sea level; but the intensity is still measurable.

The farthest extreme in the other direction has been reached by the recent rocket experiments, in which counters have been carried to a height greater than 100 miles, outside the earth's atmosphere, where primary cosmic rays are observed rather than the products of their interactions in the atmosphere.

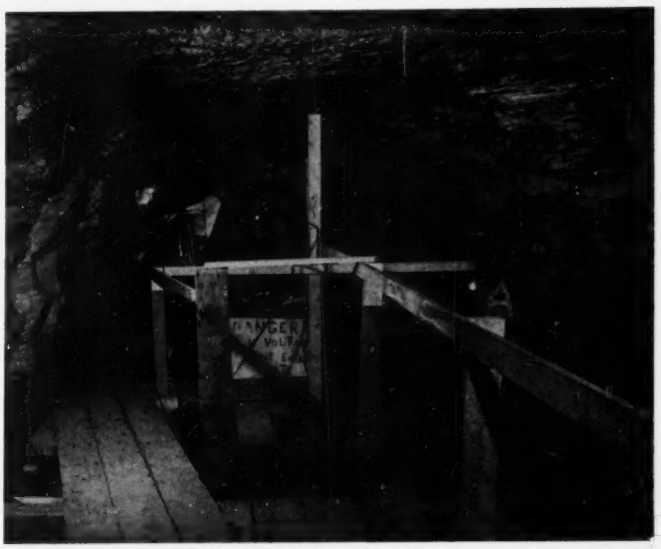
Now that a great deal of information has been collected about the abundance and kinds of cosmic rays to be found at all heights and depths, the chief purpose (beyond fun and adventure) of cosmic-ray scientists in going to different locations is to vary the nature of the beam, enriching it in one kind of particle or another, so as to study in detail the properties of the different particles and of their interactions with matter.

For instance, at sea level, we know that about 70% of the charged rays are mesons with average energy a few billion electron volts, that have the property of not interacting with nuclei to any appreciable degree. The remainder of the charged rays consists mainly of electrons with average energy less than 10^{8} electron-volts which also do not interact with nuclei. The uncharged rays are mostly photons, for which the nuclear cross-sections are small. There are appreciable numbers of low-energy neutrons, such as can easily be generated by laboratory machines. But less than one percent of the rays are possessed with both high energy and the property of interacting strongly with nuclei, and less than 1/10 percent of the particles are primary cosmic rays. As a consequence, if one observes large showers created in a block of dense material, these are due in roughly equal numbers to improbable interactions of the abundant particles and likely interactions of the rare particles.

If one changes to a mountain location such as Mt. Evans, Colorado (14,200 feet high), the energetic, strongly interacting particles are about 30 times as abundant as at sea level, while the high-energy mesons are hardly more abundant at all. Therefore one may not only record about 15 times as many interactions per day, but one may be sure that practically all of these are due to the type of particle one wishes to study. The beam may be enriched and strengthened even further by going to higher levels in airplanes or balloons, but the advantages of so doing are frequently more than offset by the inconvenience, expense, short time duration and physical limitations of balloon and airplane experiments.

There is another type of particle, discovered recently among the primary cosmic rays, that apparently

(*Concluded on page 40*)



Donald Hudson and tent sheltering Cosmic-ray detecting instruments in Ezra Cornell's tunnel. The rushing water underneath and the frequent icy condition of the planking made this experiment somewhat adventurous.

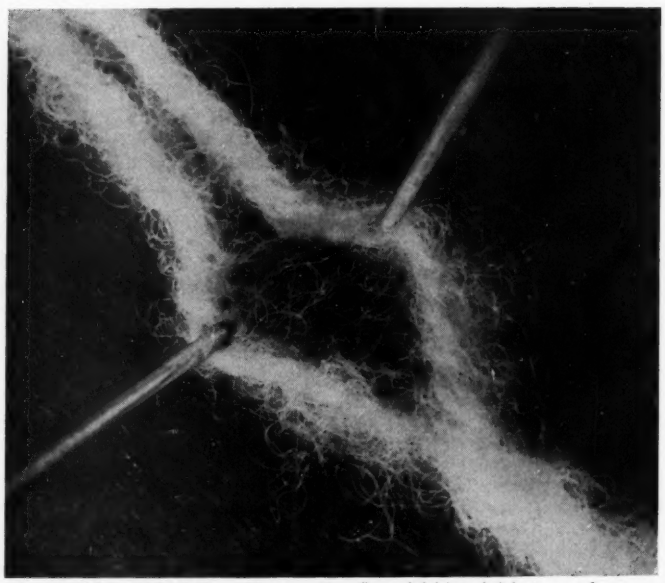
—Courtesy Cornell Photo Science Service, Sol Goldberg

† Likely the magnetic field of the sun deflects such particles away from the solar system.

Is This Really Wool?

By HOWARD SANDERS, Chem.E. '47

BECAUSE of a few launderings in a home washing machine, a perfectly serviceable woolen garment may become utterly worthless—except perhaps as a hand-me-down to one of the smaller members of the family. Even though wool in many respects is tremendously superior to the majority of clothing fabrics, one of its most serious shortcomings is the ease with which it shrinks in the presence of water.



These initially entwined fibers illustrate the effect of felting shrinkage on what were originally two separate strands of wool yarn.
—*Courtesy American Cyanimid Co.*

The Shrinkage Problem

Nothing highlighted the wool shrinkage problem quite so strikingly as the recent war. During the war, shrinkage was the reason why thirty per cent of the total number of G. I. flannel shirts were turned in for salvage. For hosiery, the percentage was even higher. Untreated woolen socks became unwearable after the first or second washing. Often, shrinkage ran as high as twenty-five per cent under field conditions.

Generally speaking, Americans used considerably more woolen clothing in the Army than they did as civilians. Yet on many world battlefronts, dry cleaning facilities were almost unheard of. The only alternative was the water washing of woolens. And that meant shrinkage.

On the other hand, even if dry cleaning facilities had been available to minimize shrinkage, the solvents used might in many instances have been completely ineffective in ridding woolen olive drabs of the type of grime picked up during combat. In such cases the water washing of woolen clothing was an absolute necessity. But since Army laundrymen could hardly have been expected to give woolen sweaters, shirts, socks, and underwear the gentle, watchful care required to avoid shrinkage, the result was freely-shrinking wool and thus unsightly, uncomfortable, or unwearable clothing. For the men whose job it was to replace unusable clothing, the short wear-life of woolens meant volumes of extra work and distribution problems galore. Particularly in time of war, this country could ill afford to pay the immense price of wool shrinkage. The job was clearly defined: *Even if wool shrinkage could not be stopped altogether, it had to be cut to the minimum.*

Urgently, the Quartermaster Corps' Research and Development Branch set to work solving the problem of wool shrinkage control early in 1943. It was a problem made doubly difficult by the fact that up until that time this country's wool industry had produced not a single item of shrinkage-resistant wool on a commercial scale.

In its all-out attack on wool shrinkage, the Research and Development Branch enlisted the aid of the National Research Council, the Textile Foundation, and representatives of both the American and British wool and chemical industries. Their joint studies proved tremendously successful. After months of investigation, they developed a chlorination method for wool shrink-

age control which was capable of reducing shrinkage from twenty-five per cent to less than five per cent. True, this did not insure the complete elimination of wool shrinkage. But it was obviously a decisive step in the right direction. Furthermore, five per cent shrinkage of a woolen garment frequently implies no great reduction in its comfort or wearability—particularly in the case of woolen socks. And it was in the manufacture of Army socks during the war that the chlorination method of shrinkage control played its most conspicuous role.

Once the war was over, enthusiastic reports confirming the remarkable stability of Army woolens made their impact on the buying public. Simultaneously, stores in many parts of the country began featuring eye-catching displays of washable woolen garments, particularly woolen sport shirts. In most cases, the manufacturers of these garments guaranteed that shrinkage was controllable to within five per cent, as compared with thirty to forty per cent for the untreated cloth after five washings. Normally, shrinkage in service never amounted to more than two per cent. As stabilized woolens began to appear more prominently on the sales counters of selected department stores throughout the nation, canny housewives were quick to sense that here in reality was a major development in the science of textile finishing.

Types of Shrinkage

What exactly is the nature of this shrinkage which has so seriously limited the all-around usefulness of wool? Actually, there are two distinct types of wool shrinkage. One is relaxation shrinkage, which occurs as the tension produced during the processing of the yarn or fabric gradually expends itself. The sponging of woolens normally permits relaxation shrinkage to take place before the fabric reaches the customer. Hence, it is ordinarily the concern of the manufacturer only. Ranging from two to fifteen per cent, relaxation shrinkage is small for tightly woven cloth and relatively large for knit or woven fabrics.

However, the shrinkage control processes now in use, with the exception of the resin treatments, are concerned not so much with relaxation shrinkage as with felting shrinkage. Actually, the resin treatments, in contrast to other methods of wool shrinkage control, minimize not only felting shrinkage but relaxation shrinkage as well. Usually the customer's dilemma, felting shrinkage results from the tendency of the fibers to migrate and curl when exposed to moisture and mechanical working. During felting, the fibers become so entangled that it is next to impossible to separate the individual threads without breakage.

Upon the felting property of wool is built much of the framework of the woolen industry. Blankets, hats, flannels, and serges—indeed, woolen clothing of all sorts—owe their essential, tightly-compacted structure to felting. But felting also places upon wool the severest of limitations. Unless the wool has been properly treated, the felting shrinkage which was deliberately promoted at the mill to increase its wearability will continue apace in the home washing machine and make the finished garment worthless.

When dry, wool does not felt to any great extent. However, once the wool is moistened, felting shrinkage proceeds rapidly. A warm alkaline liquid ,such as ordinary soap solution, speeds up the shrinkage process even more. So does rubbing of the fibers. By permitting greater movement of the individual fibers, loose fabrics tend to felt more readily than do closely-knit fabrics.

Explaining Wool Shrinkage

Over the years, scientists have proposed numerous theories in attempting to explain the exact mechanism of wool shrinkage. The explanation most widely accepted today places its greatest stress upon the part played by the fiber's outer layer of overlapping scales, actually no more than about one ten-thousandth of an inch in thickness. The shrinkage of cotton, flax, silk, and even human hair is materially less than that of wool. Under the microscope, these fibers clearly show themselves to be considerably less scaly than wool. Because of its scaly surface, a wool fiber if rubbed from tip to root is a good deal rougher than when rubbed from root to tip.

The shrinkage of wool is caused by the compacting of the cloth as the fibers are brought closer together by a general migration, the fibers moving in the direction of least resistance, namely root ends first. Once the fiber has migrated in one direction, it meets appreciable resistance in attempting to return

THE AUTHOR

Drawing from his experiences while a student trainee in Calco's Textile Resin Department, Howard Sanders writes this survey of current methods for giving wool a valuable new property: shrink resistance. Mr. Sanders, B. Chem. E. Cornell '47, has been with the Calco Chemical Division of the American Cyanamid Company for over two years now and has had a hand in the recent process development work on melamine, a chemical which plays a vital role in the manufacture of many of the leading textile resins. Mr. Sanders had a series of articles entitled "pH—Its Meaning and Determination" published in the January and February 1949 issues of "Metal Finishing".

Howard Sanders

to its former position since so much more friction is encountered in reverse motion.

Most shrinkage-control treatments in vogue today serve primarily to reduce the differential friction effect of the wool's scale structure. Hence, treated fibers felt only slightly since they are as free to move in one direction as in another.

Shrinkage Control

Methods for reducing wool shrinkage have been known for over fifty years. Nevertheless, it has only been within the past decade that the major woolen and chemical companies of the nation have made significant headway in developing techniques of wool shrinkage control. As a result, there are at present over thirty-five different, commercially important processes designed to stabilize woolens. All of these, broadly speaking, fall into two main categories: the methods employing chlorine and those involving the synthetic resins.

Chlorination

In the early days, it was generally assumed that shrinkage resistance could best be imparted to wool if its scale structure could be drastically modified or even eliminated. Success along these lines was achieved mainly with chlorine gas or alkaline chlorine solutions. If properly controlled, the chlorine treatment resulted in a partial solution of the scale structure and an approximate five to ten per cent loss in the weight of the wool.

This young lady shows the result of washing two wool sweaters, originally the same size. The one she wears, however, had been treated by a process which reduces wool shrinkage from 30 to 40% to as little as two or three percent.

—Courtesy U. S. Rubber Co.

Wet chlorination, involving treatment with an acidified solution of calcium hypochlorite, was the technique given top status during the war by the United States Quartermaster Corps. It was also extensively used in England during the war, particularly for knitted woolen underwear. The British called upon the chlorination method for the treatment of RAF and Land Army socks and trousers, as well as for the jungle-green jerseys issued to the troops in the Far East.

Resins

Of the processes most recently adopted, by far the greatest interest has been centered around those employing the synthetic resins and more particularly the melamine resins, which have long been of importance in the plastics industry. Just a few years ago, the key discovery was made that these resins, if applied to wool, could markedly reduce its tendency to shrink.

It will be recalled that the chlorination method of wool treatment results in a breakdown of the wool fibers. In an exactly contrary fashion, the resin treatment results in a building up of the fibers. The resin fills in the crevices along the tips of the scales, producing fibers smoother and less apt to migrate and interlock than untreated wool. Thus the fibers actually become more nearly like smooth, nonshrinking nylon.

One manufacturer of sport shirts decided to discontinue the use of conventional wool in favor of resin-treated wool and found that by so doing he tripled the number of his active accounts and tripled the number of his shirts sold. The washability feature of the wool had alone made the difference. After five washings in an automatic washing machine, his resin-treated garments showed no felting, no change in marked size, no change in color or sleeve length. Significantly, the resin treatment had preserved the fabric's wear resistance, warmth, texture, drape, and tensile strength. Not only was there no stiffening of the wool but rather a very decided improvement in its resiliency and ease of tailoring.

This is what happens when an untreated woolen shirt is sent through a washing machine. Poppa looks slightly disturbed by it all. No wonder, his shirt shrank 40%.

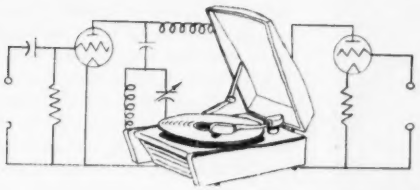
—Courtesy American Cyanimid Co.

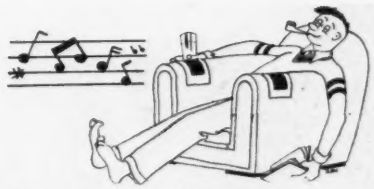
Resin-treated wool, combined with proper fabric construction, has led to the remarkable development of lighter weight, more porous, thus cooler, fabrics—combined with that essential element of crush resistance. What makes such a tremendous difference is the resin's ability to keep the air pockets in the cloth firmly in place, despite the effects of dry cleaning solvents, which frequently mat untreated wool.

For years now, buyers with a keen eye for quality have looked discerningly for the words "all wool" or "100% virgin wool" on the labels of garments and blankets. However, now that resin treatments have come into prominence, the "all wool" label may not be all that is necessary to stimulate the buying urge. Since a resin-impregnated fabric is so vastly superior to ordinary textiles, knowing customers will most assuredly insist upon a fur-

(Concluded on page 36)

High Fidelity in Recorded Music





By ROBERT L. LABELLE, ChemE '50

DURING the last year the reproduction of music has received wide-spread publicity. Among rival claims as to the quality of particular systems, one characteristic stands out—*high fidelity*. There may be some explanatory mutterings about wide-range reproduction; some talk of natural tone color; some test data displayed. But an understanding of what is involved in high fidelity and of how it may actually be realized is available only in a somewhat scattered, though excellent, literature of specialized articles — and these, of course, in technical magazines remote to the casual reader.

High Fidelity and Listening

Just what is high fidelity? How can it be obtained for example, from music in disc recordings? The discussion to follow attempts an abbreviated but comprehensive answer under two main headings: the physiological and psychological limitations of the listener, and the mechanics of the reproduction of music from disc recordings.

Before we examine the performance of the phonograph, let us consider the limitations imposed on our perception of such music as is heard directly. Three principal factors determine what the individual hears: (1) the intensity and spectral distribution of the sound, (2) the ability of the individual to hear each frequency in this spectrum, and (3) the ambient noise level in the room.

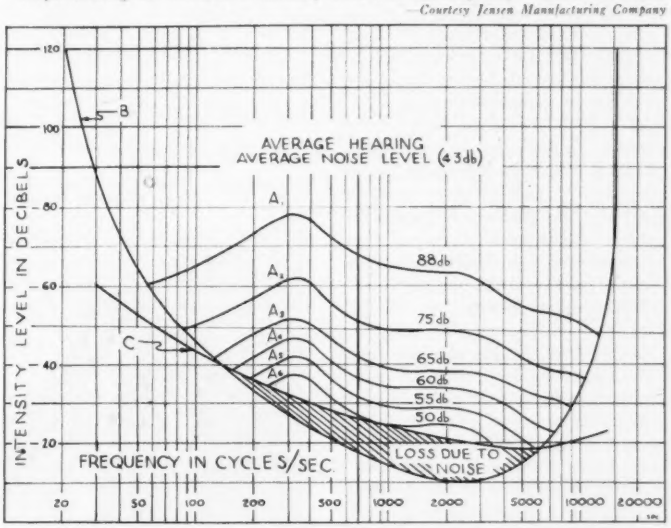
The characteristics of the sound are shown in the graphs in Fig. 1, correlating intensity, or level, in decibels with frequency in cycles per second. The graphs indicate the typical spectral distribution of the music played by a symphony orchestra at various intensities. The graph marked 88 db. illustrates the intensity experienced twenty feet from the orchestra in a concert hall, while that marked 55 db. indicates the average level at which the radio is played in the home.

Curve B shows for each frequency the lowest intensity at which the average person can just detect the sound. Note that the threshold intensity rises to infinity at both upper and lower ends of the frequency range shown, indicating the limiting frequencies which can be perceived by the human ear, about 16 to 22,000 cycles per second (cps) in extreme cases. For comparison, the notes on the piano range from 28 to 4-160 cps, the frequency doubling in each octave. Note also how this curve cuts across the orchestral spectrum, limiting perception to narrower ranges of frequency as the intensity of the music decreases.

Noise Levels and Music

In addition, when the music is at a low level, the background noise of the home becomes important to audibility of the music. The ambient noise level in the average home is 43 db., and its typical spectral distribution is shown by curve C. Everyone realizes the effect that a cough or rustling of paper has on audibility of music or of a lecturer's voice. If a noise has a 500 cps component at a level of 28 db., any component of music occurring simultaneously at the same frequency and at or below this same level, will be masked; hence the noise level becomes the threshold of perception, even though the individual can actually hear much lower intensities in quiet surroundings. Soft passages of music such as occur frequently in symphonic music suffer in particular from this masking. And these curves, which merely represent averages, do not take into account the more noticeable effect of instantaneous noises

Graph showing the variation of intensity level with the frequency of the sound wave.
—Courtesy Jensen Manufacturing Company



Stylus and record wear test.

—Courtesy The Tetrad Corporation

of high intensity, which may momentarily mask or produce discord even in loud music.

Another point that should be borne in mind is that man's perception of sound decreases as he grows older, and markedly so in the high frequencies. For example, men 55 years old have a hearing loss in the frequencies above 4,000 cps in the order of 30 db.; women have a corresponding loss of 15-20 db.

The lesson to be learned from the foregoing is that factors other than the phonographs and the records affect the observed quality of recorded music. High fidelity is not merely an objective quality, but has to be redefined for each individual, as corresponding to that part of live music he can hear under optimum conditions. If he can only perceive a frequency range of 200-6,000 cps at ordinary levels, then any recorded music including this range without distortion is, as far as he is concerned, high fidelity music. And if the ambient noise level in which he habitually listens imposes on him an even narrower perceivable frequency range, he never attains even his relatively low standard of high fidelity, regardless of the quality of the phonograph.

Psychological Factors

There is also a psychological factor involved. People who hear most of their music over small radios and phonographs, or juke boxes, become accustomed to a very restricted range of frequencies, say 150-5,000 cps, with little of the lower bass and higher treble which give the music its natural body and brightness. Even in better radios and phonographs there may be enough distortion present in the high frequencies, or so much needle scratch with its annoying high frequency components, that the listener voluntarily limits the high frequencies he hears by turning the tone control to bass. It is the experience of the author and others, that most people connect a deep bass tone with a good reproducer, even though such a bass emphasis is not characteristic of live music. Probably this paradox arises from the fact that most distortion occurs in the high frequencies and an emphasized bass tends to bury it. But such is the power of habit that they will even choose a bass setting of the tone control when confronted with an excellent reproducer having imperceptible distortion. It seems that in general people don't particularly care whether the high frequencies are present or not, *as long as there is little or no distortion* in the more restricted range to which they have grown accustomed.

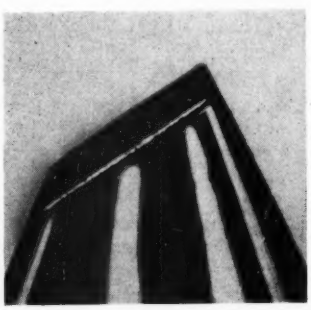
The process by which sound is recorded and reproduced is probably vaguely understood by the technically-inclined layman. A cutting tool, vibrating with the sound to be recorded, cuts a spiral modulated groove in a rotating flat disc of hard rubber coated with lacquer or shellac, or of vinylite. When the record is played back, a phonograph needle, or stylus, follows this groove and consequently vibrates in the same pattern as did the cutting tool. This mechanical vibration is translated into its electrical counterpart in the pick-up. In a crystal pick-up a piezoelectric material such as quartz generates a potential difference across its faces when strained by the movement of the needle imbedded in it. In the variable reluctance pick-up, the pattern of the much smaller voltage output is provided by the movement of the needle in a magnetic field. This signal is then greatly amplified in vacuum tubes and finally converted to acoustical energy again in the loudspeaker, at approximately the same level as the original sound.

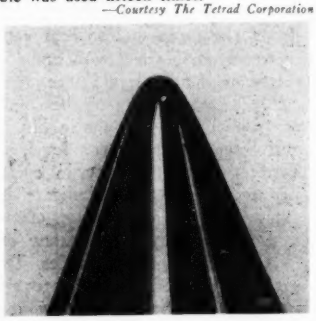
Now let us assume that we wish to record music having a frequency range of 40-16,000 cps, and reproduce it exactly, with no distortion, in a high fidelity phonograph. Since this frequency range is as wide as the most critical listener can perceive at orchestral levels, a phonograph which can give this performance is, by anybody's standard, high fidelity equipment. In practice such perfection is not realized, but through the efforts of a growing army of electronics and recording engineers, the approach to this absolute high fidelity is coming ever closer.

(*Continued on page* 44)

Comparison of Osmium and Diamond styli. The Osmium needle was used one thousand times, while the Diamond needle was used fifteen times.

—Courtesy The Tetrad Corporation



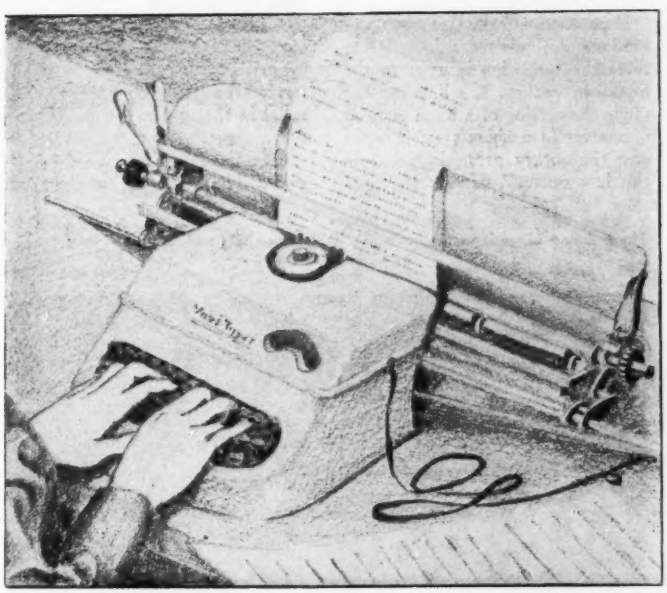


Vari-type . . . . Substitute for Linotype

By IRWIN MARGILOFF, ChemE '53

Because, in November of 1947, Local 16 of the International Typographical Union struck against five Chicago newspapers, those papers suffered the loss of their typesetters and linotypers.

In September of this year the strike was settled, and it is now history. But the processes and techniques developed by the Chicago papers to meet the loss of so important a step in their operations are of great interest. The trend in the printing industry is away from the heavy, bulky lead and metals, and toward something lighter and easier to manage.



A typist is retyping material on a Vari-typer from the original copy. This copy will appear in the newspaper exactly as it appears on the typed sheet.
—*Sketch by Stan Cohen*

Present Methods

Usually, when the copy is received from the writers, it is handed to the linotypers, who set it up on their machines. These machines produce a line of characters on a type-metal slug which is the length of the column width. This is done by depressing a key on the keyboard which allows a brass mold. called a matrix, or "mat" to fall into place in an assembling frame. Words and sentences are arranged in this way, but instead of inserting a blank mat between words, to register a space, the linotyper inserts a wedge called a "space-band" between words. When the mats and space-bands have almost filled out the frame, the operator sets the machine in motion. The frame, with the mats and space-bands, is taken to another part of the machine, where the line of mats and bands is placed between the jaws of a vise. A bar rises up under the line and pushes on the bands, expanding them, and thus pushes the words (made of series of mats) apart. When the expanded line reaches the column width desired, both margins are set firmly. This process—called justification — takes eight times as long to do with hand set type than with the linotype, and is responsible for the great use of the machine in high-speed publishing. After the line has been justified, a pot of molten metal comes forward to meet it, and a stream of metal is thrown against it. The metal solidifies almost immediately and the completed slug is then trimmed and delivered to the side of the machine, ready for assembly into a printing form. The mats and space-bands are taken away, resorted, and are ready for re-use.

After the story has been set on the slugs, they are assembled, together with engravings, hand type, line cuts, electrotypes, lines and borders, into a frame (called a chase), to make up the complete

page. When the appearance of the page is satisfactory, the whole accumulation of printing materials is locked rigidly together. A moist, soft blanket of paper is spread over the locked page, and a roller applies great pressure to the page, forcing all the details, large and small, into the paper. This is called stereotyping, and adapts the product of the linotype to the rotary press, for from this new stereotype matrix a casting may be made as a curved plate to fit on the newspaper's presses. The new, full-page mats are dried thoroughly, curved, and molten stereotype metal is thrown against them. This solidifies into a curved plate embodying all the details of the original printing materials.

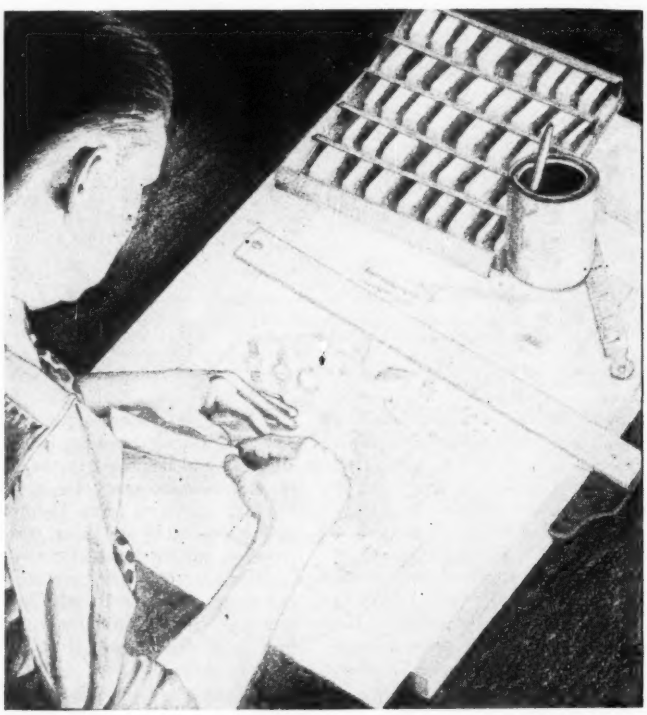
Here, then, are the two great and fundamental advances in printing since the invention of type in the fifteenth century. The linotype has made the setting of a large amount of matter in a short type feasible, and the rotary press, invented in the last century, as was the linotype, has made the process of printing a continuous one, and not a sheet-by-sheet affair. These two inventions have made our metropolitan newspapers possible. There are very many refinements of techniques, but the fundamental machines remain the same. This is true even of hand set type. Possibly the finest example of printing done with hand type is the *Gutenberg Bible*, which exhibits fine ink, format, and paper. This was the first printed material.

The Chicago Strike

But what happens when the linotypers of a major newspaper go on strike? Seemingly, one-half of the basic necessities have gone with them. Yet the Chicago papers came out as usual, and were looking better and better up till the end of the strike. Linotype slugs no longer formed the greatest part of the material in the forms, and hand typesetters, who were members of the same union local, also were out on strike. The copy was no longer set mechanically. A wholly different sequence interceded, and the series of operations from the time the copy left the hands of the writers to the time the stereotypers made their full-page mats was entirely different. Whole rows of expensive linotype machines stood idle, and composing rooms, where type is set by hand, and the pages assembled, were deserted.

The make-up editor is pasting up a page with advertising copy. A set of Fotoype pads is at the upper center.

—Sketch by Stan Cohen



How the Problem Was Solved

The machine used to set the material which appeared in the papers was the Vari-typer. This is an electric typewriter with which different type faces may be used, merely by inserting or removing a semi-circular plate carrying all the required characters of standard alphabets. But another feature of the Vari-typer, and in this case more important, is that some of the machines have a device which can justify right-hand margins, and thus produce copy similar to linotype justifying. In a newspaper, justified margins are important for easy reading and neat appearance.

There are two types of spacing on the Vari-typer. One is called the "unit"; the other "differential." In the unit system, each character has the same width as any other, as on all typewriters. The operator types the line once, counts the spaces, and finds how many spaces are used in the line. If 25 are used, and 27 is the line's capacity, a —2 is set on a dial on the machine. When the line is retyped on another portion of the sheet in the machine, a certain amount of space is inserted automatically between each letter and word, thus filling out the line to the desired width. Notice that the narrow letters— the *i* and *l*—use the same amount of space as very wide letters *m* and *w*. This visual defect is further heightened because the machine spaces between letters. The differential system allots each letter its proper width, as determined by the type designer (as on the linotype, which has a different width mat for each letter in the alphabet) and spaces only between words, so that the Vari-typed matter is almost indistinguishable from linotyped matter. In addition, some type faces are no longer covered by the copyright

(*Continued on page* 28)

News of the College

Faculty Appointments

Three new members have been added to the faculty of the School of Civil Engineering. William O. Lynch and William McGuire have been appointed assistant professors, while Arthur J. McNair has been appointed associate professor and head of the surveying department.

Professor McNair, who began teaching at the University of Colorado in 1935, is a skilled mountaineer who is credited with the discovery of Colorado Tarn, the highest body of water in the United States. A tarn is a mountain pool having less than one-tenth of a square mile of water surface. Colorado Tarn is at an elevation of 13,068 feet; McNair discovered another tarn at an elevation of 13,003 feet and during surveys in 1945-47 established a revised list of peak elevations in Colorado.

He was the organizer and first president of the Rocky Mountain Society of Photogrammetry and is a national director of the American Society of Photogrammetry. He is also chairman of the Mapping and Surveying Committee of the American Society for Engineering Education.

Professor Lynch graduated from Newark College of Engineering in 1943 and received the master's degree from Massachusetts Institute of Technology in 1947. He served during the war for more than three years as a Navy ordnance officer specializing in fire control. He came to Cornell from the Boston sanitary engineering firm of Camp, Dresser, and McKee.

Professor McGuire is a magna cum laude graduate of Bucknell, class of 1942, with the master's degree in civil engineering awarded by Cornell in 1947. He served four years with the Navy on wartime duty as an aircraft maintenance officer at shore stations and aboard aircraft carriers in the Pacific. Since 1947 he has been a structural designer with the firm of Jackson and Moreland, Boston.

Professor McNair

The CORNELL ENGINEER was judged "Best All-Around Magazine" at the annual convention of Engineering College Magazines Associated in Minneapolis Oct. 15. Selection was made by the ECMA editorial critic on the basis of content, appearance, on-time publication, and related items.

Representing the ENGINEER at the convention were Tom Kelly, publicity manager, and Howie Krasnow, treasurer. They were guests of the University of Minnesota "Technolog," and attended discussion group meetings on publication problems, besides being taken on a tour of the Bruce Publishing Co. of Minneapolis.

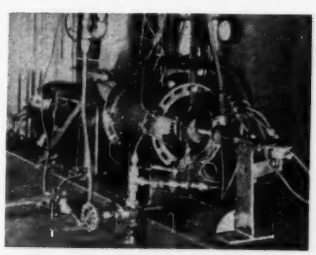
Student Lounge

Efforts to establish a lounge for engineering students and faculty members are continuing this year, with an impressive list of honorary and professional societies backing the project. Renovation and furniture procurement work has been underway since Thanksgiving, and it is expected that the lounge, located in the basement of Sibley Dome, will be opened in the near future, although it will not be completely equipped.

Last year about $480 was collected, along with a phonograph, and further drives for funds and furniture will be held this year. The goal of last year's drive was $2000, estimated to be the amount necessary to equip the lounge with a sufficiency of durable, comfortable furniture, and the group is looking for ways of procuring the funds still needed, or equivalent furniture. Organizations helping the group are AIEE, ASCE, ASME, Atmos, CSEC, CSEP, Eta Kappa Nu, Kappa Tau Chi, Pi Tau Sigma, Pros-Ops, and Tau Beta Pi.

Wave Heat-Engine

Under the direction of Professor Arthur Kantrowitz, of the Graduate School of Aeronautical Engineering, research has been carried out to explore a new field—heat engines based on wave processes. The compressors and gas and steam turbines now used in aircraft and power stations depend for their operation on work obtained from pressure changes in flowing gas, but until recently no one had considered the possibility of transmitting pressure changes by means of waves.



The experimental "wave engine"—actually a compressor—as set up for test in the laboratory of the Aeronautical Engineering School.

Brown-Boveri, prominent Swiss gas turbine makers, introduced the first practical wave machine, called the "Comprex," which was to be

(*Continued on page 38*)

Cornell Society of Engineers

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L. P. Smith, Director of the Department of Engineering Physics

William Littlewood

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

Have you ever noticed to how many organizations the men you most admire belong? If not, I'd suggest you check the observation and perhaps spend a little time browsing through Who's Who. There is a great deal to be learned from such a study.

We live and function in a social, economic and political order where the complexity of our modern tasks requires the cooperative efforts of group organization and activity. Teamwork is the method by which most results are achieved. To be associated with others in a common purpose and activity enhances your individual ability and gives you opportunities to accomplish jointly what no individual can do alone. It also provides for you the essential background against which to develop and practice those attributes of leadership which are necessary to your advancement. Expressing and expanding yourself in a social organization or in a technical group gives you direct and valuable experience to achieve similar results in your business.

Do not try to make progress alone. That is neither natural nor desirable. There are so many trite expressions—nevertheless true and forceful—which express the necessity for group action in good times and in bad. I will bore you with only two—"In union there is strength" and "Misery loves company."

What I am trying to say is that one of the smartest things you can do—and at the earliest possible time—is to team up with others in joint endeavors in all the broad fields of your life's activities whether they be religious, social, political or economic. To a mild and proper extent, *"be a joiner"* and after you join, take an active part in the workings of the group. I am sure you've noticed in any group or meeting, the relatively few who stand out and lead. They have taken my advice—first, by joining, and second, by doing! Those organizations, and your school and business, and—if I may narrow it down—your "boss"—are always looking for individuals who will stand up, and can stand out and lead! You will benefit a hundred-fold from every ounce of energy you put into proper group action. And if I may make a specific suggestion, the first group you should join and with which you should become immediately and intensely active is The Cornell Society of Engineers!

William Littlewood

Alumni News

Alanson D. Morehouse, M.E. (E.E.) '93, of Oakwood, N.C., has been serving as president of Restlawn Memorial Park, Jacksonville, Fla. He writes that he greatly enjoyed attending '93's delayed fifty-year reunion in 1946, its delayed fifty-five-year affair in 1948, and reunions this June where he met many of his friends of other classes from '89 on.

Wilbur G. Hudson, M.E. (E.E.) '97, has written a new, second edition of his book, "Conveyors and Related Equipment." Publishers are John Wiley and Sons, New York City. Hudson's address is 5541 Everett Avenue, Chicago 37, Ill.

Ralph C. Schwarz, M.E. '08, of 278 Aldine Street, Rochester, has been doing sales engineering work in the Rochester and Western New York area for many years. Recently his two sons, **Ralph C. Schwarz, Jr. AEME '42,** and **Peter D. Schwarz, EE '47,** joined his organization.

James W. Cox, M.E. '09, was in South America on business at the time of his forty-year reunion, but he drank a toast to his classmates on reunion days in Buenos Aires. He is a consulting textile engineer and his address is 40 Worth Street, New York City 13.

Tell Berna, M.E. '12, general manager of the National Machine Tool Builders' Association, Cleveland, O., spoke on "Investment in Prosperity" at an executive night dinner of the Philadelphia, Pa., chapter of the American Society of Tool Engineers, September 15.

William C. King, M.E. '16, is district manager for Electric Machinery Manufacturing Co. of Minneapolis and Cornell Dubilier Electric Corp. of South Plainfield, N. J. He is living at 912 East Third Street, Los Angeles 13, Cal.

William L. Lewis, M.E. '22, manager of production and engineering for International Business Machines Corp., was elected a vice-president of the company, September 19. He lives at 35 Crestmont Road, Binghamton, N.Y. Members of the board of directors of the newly organized IBM World Trade Corp., include **William F. Russell A.B. '10,** president of Teachers College, Columbia University, and **William L. Kleitz A.B. '15,** president of the Guaranty Trust Co. of New York. The latter was recently named general chairman of the 1949 fund drive of the Travelers Aid Society of New York.

William L. Lewis

Frank Rizzo, E.E. '24, has been appointed deputy chief of the Government Section of General MacArthur's headquarters in Tokyo, Japan. He originally joined the staff in August, 1945, when GHQ was located in Manila, P. I., and moved to Japan in September, 1945. He was relieved from active duty in the United States Army in October, 1946, but continued in occupation duties as a Department of the Army civilian. His address is Government Section, GHQ, SCAP, APO 500, San Francisco, Cal.

Amicus Most, C.E. '26, formerly with the Parkway Foundry and Machine Company, is now First Vice-President and General Manager of the New Haven Clock and Watch Company, New Haven, Conn.

Gerald K. Hollenbeck, M.E. '29, is with the refrigerator cabinet division of General Electric Co., Erie, Pa. His address in Erie is 1045 Napier Avenue, Lawrence Park.

The CORNELL ENGINEER earnestly solicits all newsworthy items about alumni of the College of Engineering. This section of the magazine is designed to be of service in keeping Cornellians in touch and will function well only if the alumni themselves help to keep its columns interesting.

James F. Hirshfeld, A.B. '34, M.E. '36, M.M.E. '37, has, in conjunction with W. H. D. Hinchman, organized the Hinchman Corp., Francis Palms Building, Detroit, Mich. This corporation is an outgrowth of the W. H. D. Hinchman Co., which will expand the underground electronics survey work, non-metallic minerals and activities and the other non-engineering functions of the original company. Mr. Hirshfeld, who will serve as Vice-President and General Manager, was formerly with the Great Lakes Steel Corp., Stran Steel Division, as Chief Engineer and Assistant General Manager.

Sanford J. Klion, B.M.E. '46, is a design engineer with The Kellex Corp., in New York City and his address is 39A Grammercy Park, New York 10. Last February 22 he married Marilyn Prager, Hunter College '49. In June, 1948, he received the M.S. in M.E. of MIT. While there he was elected to Sigma Xi.

CORNELL

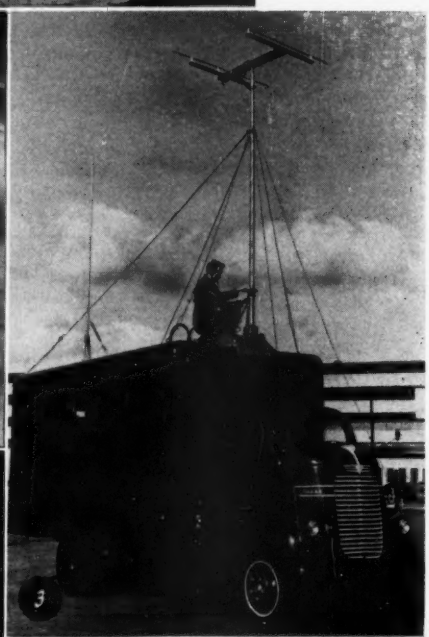
By

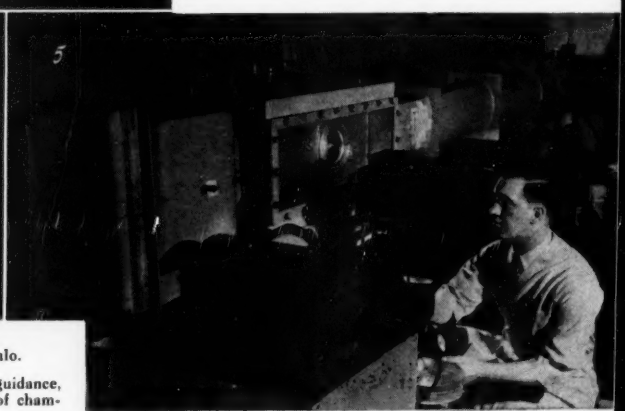
By ROBERT L. LABELLE,
ChemE '50

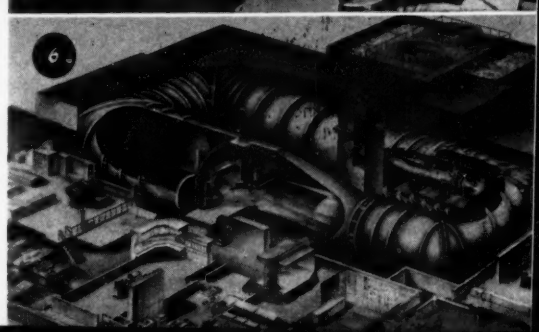
The Cornell Aeronautical Laboratory is, for the average Cornellian, as unfamiliar as the Medical School in New York. However, as a part of Cornell, and particularly interesting one, it deserves our attention.

The Cornell Aeronautical Laboratory came into being in 1946 when Curtiss-Wright Corporation gave its completely equipped research laboratory in Buffalo to Cornell. A further gift of a working capital fund by six leading aircraft corporations made its operation possible. The five-million-dollar corporation is wholly owned by Cornell University and its president, Theodore P. Wright, is also Vice-President for research at Cornell.

As a laboratory of applied research, it bridges the gap between the fundamental research of the university and the practical applications of industry. Although the Laboratory engages in extensive research for government agencies and







1. Exterior view of the Cornell Aeronautical Laboratory in Buffalo.
2. Acoustic problems, important in the field of flight control and guidance, are studied in the Engineering Physics Department's sound-proof chamber.
3. A mobile telemetering station permits remote observation of flight test data.
4. In the model shop, skilled woodworking produces exact aircraft models for flight or wind tunnel testing.
5. A supersonic wind tunnel in the Aerodynamic Research Department, capable of producing air velicities of 1400 miles per hour. A Schlieren apparatus photographs shock wave patterns in the air flow.
6. Diagrammatic view of the variable-density tunnel of the Wind Tunnel Department, showing its complexity and size.

AERO LAB

Photographs Courtesy CAL

industry on a contract basis, it is a non-profit organization, operating entirely in the public interest. Net earnings are used to support laboratory-instigated research and educational activities in cooperation with Cornell University.

Six hundred scientists, engineers, and technicians staff the Laboratory and carry on a variety of research problems. They are divided among seven technical departments: Wind Tunnel, Flight Research, Aerodynamic, Aero-mechanics, Materials, Engineering Physics, and the Development Division.

Of major interest is the variable-density, high-subsonic wind tunnel, representing three million dollars of the total capital value of the Corporation. Models with a span of ten feet can be tested at wind speeds up to 750 miles per hour. Contributing to the efficiency of the wind tunnel operation, lock gates

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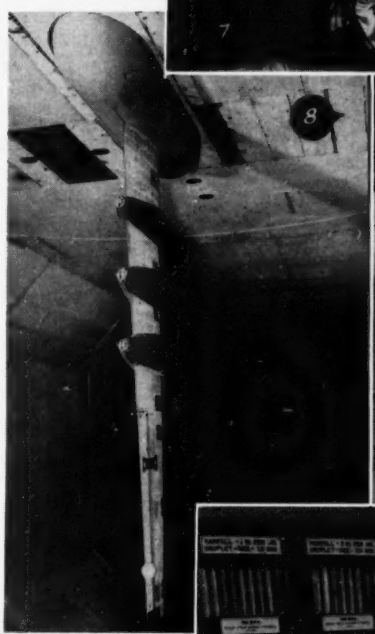

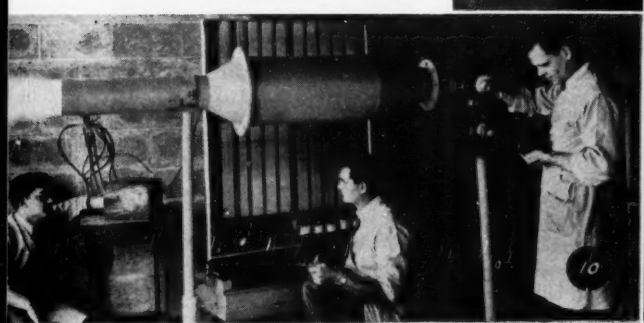

7. Control room of the Laboratory's variable-density wind tunnel. All data is recorded automatically on IBM cards for record and subsequent analysis.

8. A flutter research model of a multi-engined airplane wing mounted in the 12-foot wind tunnel.

9. Altitude chamber in the Development Division is capable of simulating altitudes of 70,000 feet and maintaining temperatures of 85°F below zero.

10. This burner test stand permits the study of the action of jet propulsion units under operating conditions.

11. Rain erosion of plastic studies—typical of the techniques used in the evaluation of structural materials.

12. A development project of the Laboratory is this air-supported building for the housing of specialized equipment. It is capable of supporting as much as three tons of ice and snow.

SCHOOL

Professor Burrows

Electrical Engineering

Charles Russell Burrows was born in Detroit, Michigan on June 21, 1902. He spent his early school years in Washington, D. C. As a graduate of Curtis High School, he entered the University of Michigan in 1920. From childhood his interests centered in electricity and magnetism, so there was no indecision in the selection of a career.

Upon his graduation from the University of Michigan in 1924, he returned to the radio research department of the Western Electric Company. Dr. Burrows was a member of the technical staff of the engineering department of the Western Electric Company and their successor, the Bell Telephone Laboratories, continuously from his graduation until September 1945. He came to Cornell as Professor of Electrical Engineering and Director of the School of Electrical Engineering at Cornell University in September 1945.

Early in his career with Bell Telephone Laboratories, Dr. Burrows specialized in radio wave propagation. During this period he received his Master's and Doctor's degrees in Physics from Columbia University, and his professional degree of Electrical Engineer from the University of Michigan. His analysis of trans-Atlantic short wave radio propagation formed the basis for the designing of this type of telephone service. Similar research by him on short wave propagation to South America preceeded the installation of the radio telephone service to South America. With the beginning of interest in ultra-short radio waves for communication purposes, Dr. Burrows led a group of engineers in an experimental and theoretical investigation of these waves. This included an intensive investigation which uncovered the basic mechanisms of wave propagation and allowed the estimation of propagation conditions on all types of transmission paths.

A year before our entry into World War II, Dr. Burrows and a group of engineers working under his supervision, contributed to the development of the proximity fuse being developed by Section T of the National Defense Research Committee. Early in the war he worked on the design of the SCR 545 Radar Set and served as a consultant on antennas at the Aircraft Radio Laboratory of the U.S. Army at Wright Field. On returning from his radar mission to England, Dr. Karl T. Compton asked Dr. Bur-

(*Concluded on page* 34)

Mechanical Engineering

Harold J. Loberg, the acting director of the Sibley School of Mechanical Engineering, is a Cornell man of long standing, and well known to many of us.

Originally from Michigan, Mr. Loberg came to Cornell after three years at the U.S. Naval Academy, for a degree in mechanical engineering. He graduated with the class of '29, and obtained a position with the Norton Company of Worchester, Mass., as a sales engineer for machine tools.

After five years work in the field of sales engineering, Mr. Loberg returned to Cornell for a masters degree in engineering.

While working for his degree, he held a position as an instructor in the department of Industrial and Engineering Administration. After receiving his degree, he remained with the department, advancing however to the rank of professor, and in 1942 was appointed acting head of the Department. During the war, Mr. Loberg carried a double burden, for he served as director of the Navy's Steam and Diesel Engineering program at Cornell in addition to his duties with the Industrial and Engineering Adminstration Department.

Following the recent resignation of W. Julian King, until June director of the School of Mechanical Engineering, Mr. Loberg was appointed acting director of the school in addition to his regular duties as head of the Department of Industrial and Engineering Administration. Mr. Loberg's reputation is not confined to the campus, however,

Professor Loberg

since he is well known outside of the University for his many articles and his work as the director of the sales engineering training program of the National Association of Machine Tool Manufacturers.

Civil Engineering

With a warm handclasp and a pleasant western twang to his voice, Dr. Nephi Albert Christensen, Director of the School of Civil Engineering, ushered us into his office on the first floor of Lincoln Hall. He is a native of Provo, Utah, and

DIRECTORS

did his undergraduate work at Brigham Young University, where he majored in mathematics, and was active on the swimming and track teams. With a smile he will tell you that he threw the javelin 160 feet, which was a pretty good throw then since the sport was only about five years old. Several of his professors at that time were Cornell men, and Dr. Christensen first heard about Cornell from them.

Dr. Christensen received his B.S. in civil engineering at the University of Wisconsin in 1928 and the next few years found him working for the Wisconsin Highway Commission and teaching at Ricks College in Idaho. He obtained his M.S. and Ph.D. degrees at California Institute of Technology in 1934 and 1938 respectively. While going to Cal. Tech. he taught engineering courses, was a special lecturer at the University of Southern California and did research work in hydraulics on problems connected with the Roosevelt and other western dams.

In 1938, Dr. Christensen was appointed Dean of Engineering at Colorado State College of Agriculture and Mechanical Arts. He continued to teach various engineering courses and served as Chairman of

(*Concluded on page 26*)

Professor Christensen

Chemical Engineering

Dr. Fred H. Rhodes, Director of the School of Chemical and Metallurgical Engineering since its establishment in 1937, is a man with an interesting background.

He received his AB at Wabash College in 1910. There he had taught English and mathematics for a time. From there he came to Cornell as a graduate student and assistant in Chemistry. He was awarded the degree of Doctor of

Professor Rhodes

Philosophy in 1914. After spending a year at the University of Montana as an assistant in chemistry, he returned to Cornell as Instructor in Qualitative Analysis. During his residence at Montana, he also acted as consultant for the Anaconda Copper Company.

In 1917 he left Cornell to join the Barrett Company at Frankford, Pa., as research chemist, and later, as Director of Research for the Chemical Division of the Company. During this time he developed the process used in the first American plant for the manufacture of alizarin, and directed research on the manufacture of synthetic phenol, the refining of coal-tar products,

(*Concluded on page 30*)

Professor Smith

Engineering Physics

Professor Lloyd P. Smith is a man with no correlation between name and accomplishments. Although his name is a common one, his reputation as one of the top men in physical research establishes him as a certainly uncommon individual.

At the start of his education at the University of Nevada, Lloyd Smith moved quickly academically and, for that matter, athletically, holding the distinction of having run the hundred yard dash in the very respectable time of ten seconds flat. In addition, his musical interests were rather keen, as shown by his participation in the band and the orchestra while giving piano lessons on the side. In fact, his musical inclinations were so strong that he had actually planned for a time on becoming a concert pianist. He soon decided against this course upon consideration of the difficulties involved in reaching success in that field. The wisdom of his choice to continue in research is evidenced by the notable success that is his.

Upon graduation in 1925 with a B.S. in E.E., Lloyd Smith went to work for the General Electric Company, where he gave the first correct theory on detector action in high vacuum tubes. He soon came to the realization that his training was insufficient for the research he was planning to do. To remedy this situation, he came to Cornell under the coveted Coffin Fellowship and gained his Ph.D. in 1930.

(*Concluded on page 34*)

SCHOOL SOCIETIES

Tau Beta Pi

Jules Bigio '50
Albert Bentley Bishop '51
David Henry Blauvelt '51
Emery Frederick Boose '50
William Chambers Brasie '51
Robert John Burns '50
Ronald Squire Clark '50
Robert James Collins '50
John Charles Corbin '50
Ernest Carrington Dawson '50
Francis Robert Emmett '50
Charles John Fiden '50
Robert Thomas Gorman '50
Charles George Gorss '50
John Gude Gisnell '50
William Edward Gubb '50
Elmer Joseph Guran '50
Joseph Richard Herr '50
Fred Himelfarb '50
Alan Roy Honig '50
James Cantine Huntington Jr. '50
Loren Frederick Kahle Jr. '51
Thomas Joseph Kelly '51
Durward Bellmont Kennedy Jr. '50
William James Kingstone '50
Paul Hugo Kirchner '50
Noboru Kondo '51
John William Laibe '51
John Howard Lane '50
Louis Andre Lamoreux '50
Bernard Lawrence Loring '50
David Boyd Marsland '51
Harold Frederick Mason '50
James Gordon McMillan '50
Robert Charles Mill '51
Charles Calvert Peterson '51
Edward Joseph Querner '50
David Harry Ross '50
Irving Ross '50
George Doan Russell '50
Theodore David Schultz '51
Norman Clifford Small '50
Allen Wyatt Smith '50
John Joseph Tewhill '50
Norman Francis Toda '50
William Arthur Trautman '51
Leon Weintraub '50
Roger Knapp Whitney '50
Journ Ting Yee '50

Tau Beta Pi elects its membership from students in the College of Engineering and from the College of Architecture. Members are selected on the basis of their scholastic average.

A.S.M.E.

At a joint meeting of both the senior and junior branch of the ASME on October 6, Professor Paul Eaton of Lafayette spoke on "An Engineer Looks at China," dealing with his experiences in China on a special State Department mission.

Professor Eaton, whose varied background is linked both with Cornell and higher education in China, told of the need for technical literature among Chinese engineers, and the wartime struggles to compete with modern logistics by means of mass man-power. He warned that the influence of the American trained Chinese engineers and scientists was waning and that the fight against Communism in Asia was losing ground rapidly.

A highlight of the evening was the presentation of a charter to the student branch by Dean Dexter Kimball, and citations to George D. Russell and Professor Mabie for their excellent work with the student branch.

A.S.C.E.

The student branch of the ASCE spent an active October, starting the fall term with a student-faculty smoker on October 10. At the regular meeting on October 12, they heard Mr. Kurt Billig, of England, speak on "Pre-stressed Concrete." Plans were brought forth for an extensive program of lectures, movies, and field trips of interest to all branches of Civil Engineering.

The planned program was swiftly augmented by a field trip to the rising structure of Statler Hall, under the guidance of Professor Mains, and a lecture on "Bridge Foundations" by Mr. Kenneth Coy, of Pittsburgh.

Chi Epsilon

Chi Epsilon, honorary society in Civil Engineering, held its fall smoker on Nov. 2, for the purpose of becoming acquainted with those men eligible to be elected to the society.

The Editor's COLUMN

A DIFFICULT CHOICE

Once again the time of the year is approaching when the graduating senior, in anticipation of coming interviews and job offers, makes himself evident. Out of the college routine he suddenly emerges, clothed in a neatly-pressed suit, his hands clutching application forms of every description.

Rightly so, since for him it is a time of decision as to the nature of his future work, a time for which he has been preparing himself for four years. Perhaps then it is also the time for self-justification of the factors that he considers will control his decision.

It has been increasingly evident in recent years, especially to personnel officers of large corporations, that the search for personal security is becoming the deciding factor in the graduate's choice of employment. Not that personal security is not important; obviously, it is necessary for the well-being of every individual. However, it appears that as a result of living in a period of depression and war, followed by years of uncertain peace, the present-day graduate has a tendency to place too much dependance on security rather than on adventure and independence of thought and action.

The harm of such an overemphasis has been outlined by Dr. Vannevar Bush, president of the Carnegie Institution, who in a recent address on this subject stated that "a passion for personal security is an opiate which tends to destroy the virile characteristics which have made us great."

Obviously, the choice of the better path to follow is up to the graduate. But, as Dr. Bush declares, "if the youth of our land wish adventure and the conquest of new horizons, great possibilities lie before us. The application of science has much yet to offer, and a strong country can maintain our national security and give us opportunity to develop our great potentiality."

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DO YOU REMEMBER when winter meant storing the family car till spring? Not so many years ago, a car owner's fear of an ice-shattered motor was a dread reality . . . if he *didn't* drain his radiator and store his car once cold weather hit!

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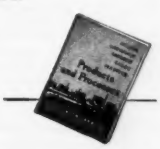

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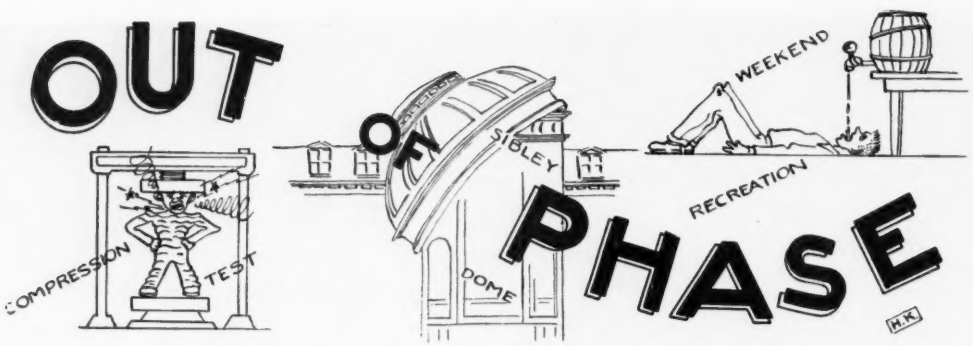

HERBERT F. SPIRER, EP '51

It's own page of Prominent Engineers:

Edelweiss Greenlouse, ME

Edelweiss first saw daylight in East Memphis, Tennessee, twenty-one years ago. After moving to St. Louis, to Chicago, to Peoria, to Reno, back to East Memphis, and to Atlanta, Georgia, his family settled in San Quentin for a twenty year stretch. Edelweiss attended Mount Parraflop Prep School in Reno, Nevada, for six years before he entered the Sibling School of Mechanical Engineering in 1945.

Edel is a member of Phi Iota Gamma, social and gustatory fraternity. He was president of the latter organization until last spring when he came down with yellow jaundice. Other campus activities have been ROTC stables, Sibley Basement, lacrosse, low altitude bombing, Risley Hall, the SPCA, Willard Straight men's room, publicity representative for the Inter-Varsity Christian Fellowship, butt-scrounging and sniping, and he is a member of the Sewer Cleaners Honorary Society. Ed was a Freshman Camp counselor until the Reverend Ritchie caught him selling French postcards.

Greenlouse' roommate, John Mossback, Arts '57, is a physics major, but Ed says he doesn't mind. Ed has spent six months trying to teach his roomie how to count the number of scales on a beginner's slide rule. John is now up to two. They make a wonderful team, as only last week Ed learnt how to use his toes as an aid to addition and subtraction.

The reason Ed has so many extra-curricular activities is that he has made "never let your schoolwork interfere with your education" his motto. Even though this has caused his marks to drop below passing, he thinks that his time here has been well spent. Ed's parting remark was "I would rather be a big wheel than pass a prelim."

Consuella Altfarb, ChemE

If you should come across a pretty dark-haired girl wandering around the halls of Olin, don't assume that she is sight-seeing, or lost, but date her up immediately. It is certain that she is not Consuella.

Although born in Trumansburg forty-eight years ago, Consuella (just call me Sue) has called Syracuse her home town all her life. Consuella attributes her dawdling interest in chemical engineering to the fact that her father, an itinerant chimney sweep, badly needed someone to support him. Consuella was a legacy to Cornell in 1896. (Maternal side, Eunice Blmnph, H. E. '70).

In spite of the difficulties of being a woman in a man's field, Consuella's college career has been less than remarkable. It has been positively dull. In her first year (1912) her average soared somewhere around 69.8 while her chug-alugging speed decreased from 0.29 secs. to 0.13 seconds. After eight years of college her average still rests around 69.9 while her drinking speed has decreased to 0.098 secs.

When we interviewed Consuella we found her deeply engrossed in her studies. These she changed for a pair of pajamas. Despite her scholarly attitude Consuella is quite the girl about campus. She is a member of Pie Alamodia, the female engineers' honorary hen party. She belongs to the American Society of Female Engineers, is local commissar for the American Society for Teasing Males, (the ASTM you hear so much about in Sibley), is a leading spark in the Cornell Association for the Advancement of Retarded Students, and her favorite hobby is chewing tobacco.

Consuella's favorite course is stoichiometry which she has taken forty-two times. As Sue herself says "It ain't the subject matter which keeps me in de course, it's the perfesser. Dusty is like a brother to me. He never speaks to me."

Allan Clobbleman Flugelfink, EE

Cornell seemed to be a logical choice for Allan Clobbleman ("urp") Flugelfink, since every other college and seminary in the country had rejected him. Electrical Engineering attracted him because in his foolish youth he had jammed his hand into a light socket, and ever since then he wondered why the lights went out.

Allan came to Cornell sixteen years ago like any other freshman, on the Lehigh Valley. His first three years as a freshman were like those

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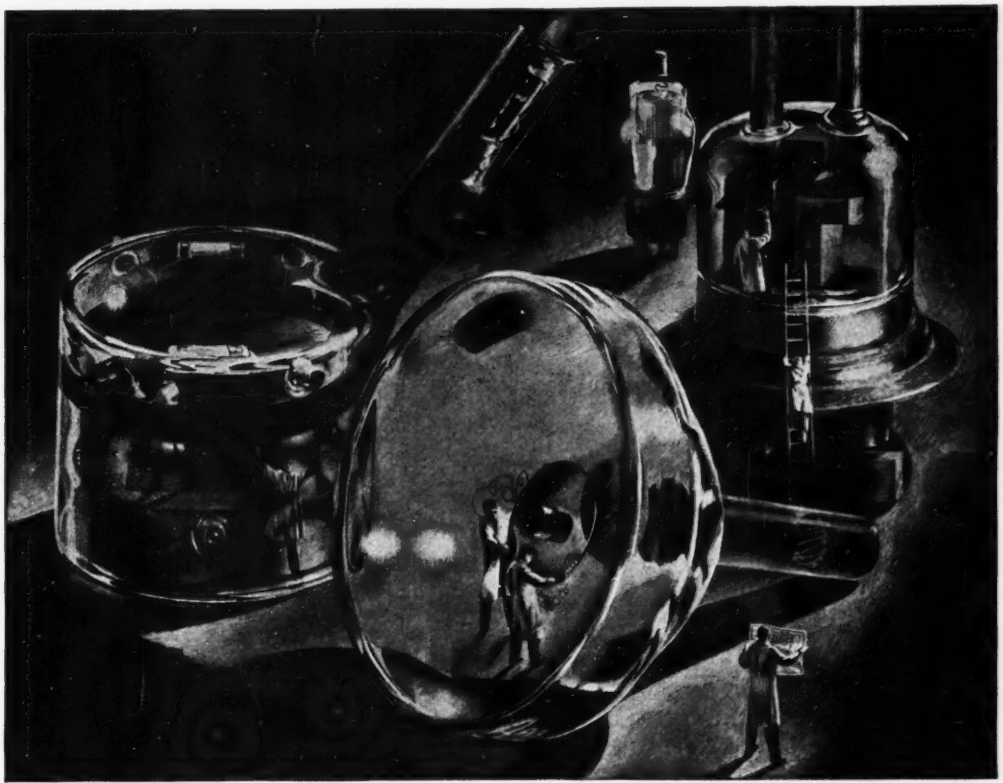

Scientists at RCA Laboratories solve exacting problems within the "nothingness" of vacuum tubes.

Inside story of Better Television

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Examples of the newest advances in radio, television, and electronics—in action—may be seen at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, Radio City, New York 20.

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Out of Phase

(*Continued from page* 24)

of any other freshman. It was during those hectic happy years that Al learnt so much about the Clinton Bar that now everyone says of him "He's a good Joe."

Gefilte Phi, the honorary EE beer guzzling fraternity, welcomed Al with open arms and palms, after he passed the initiation test of drinking two quarter kegs of zinfandel and swimming around Beebe lake three times in December. As Al's fellow drunkards say "Al is an alright Joe."

Al first saw the light of day in Mickey's Place on River Street in Hoboken when a man looking like Ray Milland screamed something about bats and jumped through the wall. The opening in the otherwise solid structure allowed sunlight to fall into Al's eyes for the first time at the age of seventeen. Being unaccustomed to sunlight, Al started to blink, which he has been doing ever since.

Al is on a State scholarship which he got with ease as he was the only one in his county to apply for it. Al's other scholastic triumphs were burning out two meters in Electronics lab which he successfully switched into someone else's experimental hookup, copying twenty-five Materials Reports when blindfolded for an overall average of 96, flunking Patternmaking, losing two transits while taking Surveying, and setting fire to freshman chem lab by pouring sulfuric acid down the back of his lab partner's trousers.

When Al graduates he hopes to find employment manufacturing drip pans for grid leaks, pots for cathode flowers and geranium diodes, or else go into sales. Al feels that his fortune will be made when he starts selling nickels to put in behind burnt-out fuses for fifteen cents apiece. "Steinmetz told it to me when he was on a four-day bender in Omaha," says Al of his great idea, and somehow we feel that he might be right. As Al's friends, both of them, always say, "Al is a bright Joe."

School Directors

Civil Engineering

(*Continued from page* 21)

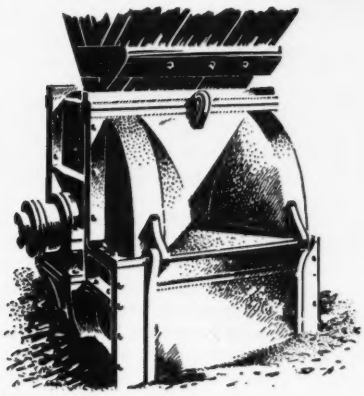
the Engineering Division of the Colorado Experiment Station.

When the war broke out, Dr. Christensen received a leave of absence from Colorado A&M to serve successively as Chief Engineer of Ballistics Research Laboratory and Chief of Research Branch of the Ordnance Research and Development Service at Aberdeen Proving Ground.

Last year, when the post of Director of the School of Civil Engineering was open, Dr. Christensen accepted it, happy to come to the school that he had heard so much about. He is now a familiar figure to all those who frequent Lincoln Hall.

The director is a member of Tau Beta Pi, Sigma Xi, Chi Epsilon and Sigma Tau. He is also a member of ASCE, American Society for the Advancement of Science and the American Society for Engineering Education.

Another page for **YOUR BEARING NOTEBOOK**

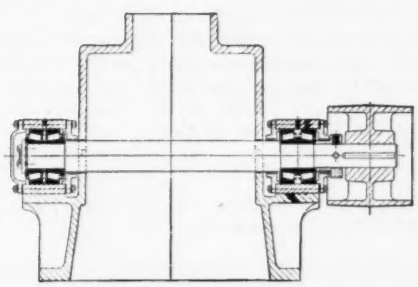


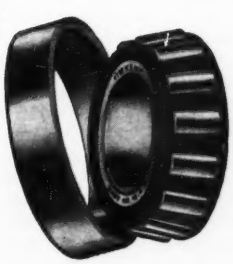
How to improve a wood hog's appetite

The wood hog shown here chews up logs for paper pulp like a giant pencil sharpener. As they chip away at the logs, the revolving cutter knives impose heavy shock loads on the bearings. To carry these shock loads, engineers specified that the cutter shaft be mounted on Timken® tapered roller bearings. Due to the line contact between the rolls and races, Timken bearings have extra load carrying capacity —take the heaviest shock loads.

Here's how engineers use TIMKEN® bearings for heavy shock loads

To give extra support to the wood hog's main shaft, double-row Timken bearings are used. The tapered construction of the rolls and races enables Timken bearings to carry both radial and thrust loads in any combination. Shafts are held in rigid alignment, end movement eliminated. Because Timken bearings permit the use of effective closures, lubricant stays in and dirt and moisture are kept out.





TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Want to learn more about TIMKEN® bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◐ AND THRUST —◐— LOADS OR ANY COMBINATION ✳

Vari-Type

(*Continued from page* 14)

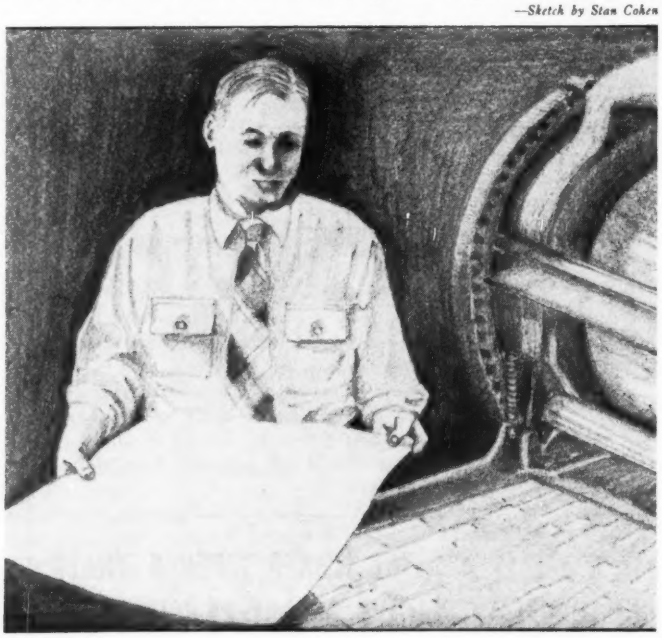
laws, and may appear on both the linotype and Vari-type. For instance, the CORNELL ENGINEER is set in Linotype Caslon, a member of a family of type faces designed by William Caslon, an Englishman, who died in 1766. Caslon also appears on Vari-type faces.

It might seem that this process would displace the use of the linotype in newspaper operations entirely, from the standpoint of greatly reduced initial cost and amortization. This is not so, however, and for a variety of reasons. These will become apparent when the further steps in this substitute process are mentioned. After the news and features have been Vari-typed, the make-up editor determines the appearance of the paper. The first step is to locate the position of advertising matter. In the case of the ordinary paper, he takes the engravings or electrotypes of the ads and places them in forms numbered for the pages on which they are to appear. Later on, the news follows in the form of slugs, with headlines set in type, and engravings placed in the forms. Then the stereotyping.

In the case of the struck newspapers, this was usually not the case. The *Chicago Daily News*, and the *Chicago Journal of Commerce*, required that all their advertisers submit proofs of the ads printed on glossy paper. The *Chicago Tribune* required the advertiser to furnish an engraving or a mat. If the advertiser had neither, an outside shop made the engraving for the *Tribune*, and after use, it was sold to him. News was set on the Vari-type in columns. Then it was made into a plate by a photoengraving process. Flat castings of advertiser's ads were made from mats submitted by them. The *Tribune* assembled the various flat castings, engravings electrotypes and borders on the bed of the stereotyping machine, and a mat was made of the whole page. The *News*, *Journal of Commerce*, and *Herald-American* preferred to assemble proofs of ads, prints of pictures, drawings, headlines, and Vari-typed copy on one large sheet of paper, then photoengraved the entire page, and made a single engraving. The *Journal of Commerce*, which confines itself to statistical tables and ordinary copy, had no engraving plant, and suffered delay in the jobbing out of engravings.

Here a worker is shown putting a mat on a locked page form before pulling a switch that will send the mat-covered form under the huge roller at right for a mat-impression.

—Sketch by Stan Cohen



Other Problems Encountered

Headlines were a major problem. They were set, before the strike, either on machines, or with hand type. When neither of these two methods were possible, the most widely used substitute was "Fotype," which consisted of pads of letters in all the usual type faces which could be arranged in rows, secured with transparent tape, and photoengraved in the same way as the rest of the material on page. All the papers but the *Tribune* used Fototype. Circumventing the union (with permission), the *Tribune* had new type cast which was set by office workers in small wooden frames, in place of the usual composing sticks used by hand typesetters. Proofs of these hand set headlines were placed above their news stories, and were photoengraved at the same time.

Speed is one of the most important elements in the production of a newspaper, and several noteworthy methods were devised to help beat the deadlines. One was called "graphic," which was nothing more than a series of stencils identical with those used on addressograph machines. They were arranged in columns (unjustified) and were backed up with a sandwich-like filler of plaster and metal, after which came the stereotyping. This eliminated the photoengraving of a plate with raised characters, since the backing of plaster afforded enough resistance to the stereotyping roller.

The engraving is by far the most time-consuming feature of this substitute sequence, and is the reason why it will never displace the present method. This does not mean to imply that the present methods will never be outdated. Engraving is a slow process, taking perhaps five or more times as long as the linotype to produce material ready for stereotyping. A paper thus dependent on engraving loses the flexibility it should have for changing the format for successive editions. It may take 90 minutes for a new plate to be made in the engraving process, and perhaps as little as ten

(*Concluded on page* 32)

Is a cable covering flameproof? Will it resist high temperatures when it comes to actual service?

Long before a cable is manufactured, questions like these are answered in the Okonite laboratories, proving ground and in various testing departments of the Okonite plants. The picture above shows a flame test. The measured current that makes the coils glow makes it possible to reproduce test after test without variation. The Okonite Company, Passaic, New Jersey.

OKONITE OKONITE SINCE 1878 5238

insulated wires and cables

UNUSUAL CORNELL GIFTS

For the folks:

Cornell Calendar by "Morgan" $1.75
(A perennial favorite)
Drinking Glasses with Cornell Seal
Packed in dozens .....3.50 up
Cornell Plate — with Designs 2.00

For sister, brother:

Juvenile T-shirts 1.00
Cornell Hat — Cornell 19?? 1.00
Scarf with Cornell insignia 1.50
Animals of all kinds — from Dogs
— to Zebras ..... from 2.00

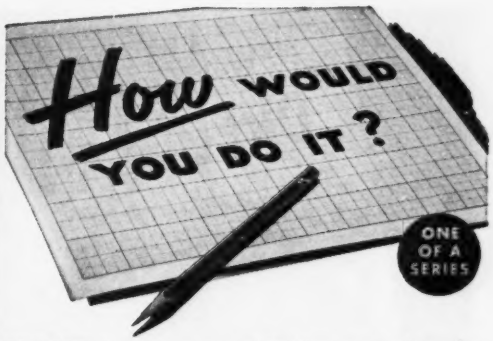
For Her:

Say it with Cornell Seal Jewelry — The lasting gift — Your choice of bracelets, compacts, lockets, pins, or what-have you.

May we suggest your shop early. We will gift wrap and lay aside for you.

TRIANGLE BOOK CO-OP

Evan J. Morris, Proprietor
412 College Avenue Sheldon Court



PROBLEM — You are designing a machine for doing finishing operations on the production line, such as grinding, polishing, buffing, etc. Your problem is to provide a drive that permits the grinding or polishing wheel to be moved around freely while it is running. How would you do it?

THE SIMPLE SOLUTION — Use an S.S.White power drive flexible shaft to transmit rotary power from a suspended or pedestal-mounted electric motor to the handpiece which holds the finishing wheel. This gives you a portable unit that permits the wheel to be readily manipulated to reach all points.

Here's how one manufacturer did it.

* * *

This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these useful "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U. S. Pat. Off. and elsewhere

WRITE FOR BULLETIN 4501

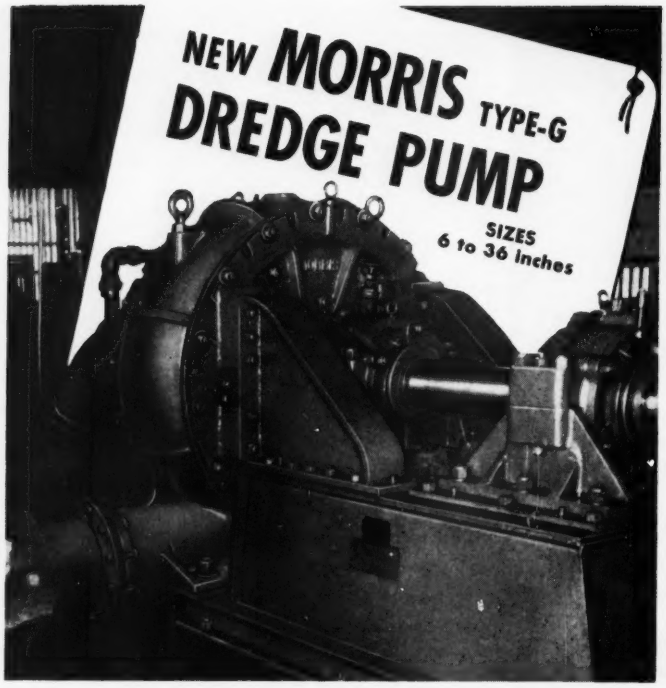
It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. DEPT. C, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED INSULATION • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises



Your ticket to a

LONG RUN PERFORMANCE

with Minimum Power Consumption

What do we all want most in a dredge or materials handling pump? There is only *one* answer — *the lowest possible overall cost per yard or ton.* You've got it in the new Morris Type G. Intervals of down-time are few — because Type G is simple, rugged, fool-proof. Power consumption is cut to the bone, over a large range of capacities — through long or short pipe lines — against high heads or low. You'll be amazed at the performance of this new Morris Dredge Pump — but take a look at these design and construction features and you'll know why this "work horse" is being called "the most efficient dredge pump ever built."

1. **Runs maximum length of time under high, sustained output—without replacements. That means LESS DOWN-TIME.**
2. **Designed with fewest possible wearing parts—and these have longer life. That means LESS DOWN-TIME.**
3. **No complicated seals or sealing rings—less vulnerable points. That means LESS DOWN-TIME.**
4. **Unusually easy to dismantle, and reassemble. That means LESS DOWN-TIME.**
5. **Has Morris exclusive balanced impeller—less thrust—longer bearing life. That means LESS DOWN-TIME.**

Just issued — Write today for detailed literature about this New Morris Type G Dredge Pump

MORRIS MACHINE WORKS
Baldwinsville, N. Y.

MORRIS *Centrifugal Pumps*

Branch Offices in Principal Cities

School Directors

Chemical Engineering

(*Continued from page* 21)

the manufacture of synthetic organic chemicals, and the distillation of coal-tar and coke oven light oils.

In 1920 he returned to Cornell as Professor of Industrial Chemistry. In 1931 the curriculum leading to the degree Chemical Engineer was first offered. This course was directed and administered by a committee of faculty members of the Department of Chemistry and the Sibley School of Mechanical Engineering, with Professor Rhodes as chairman. In 1937 the School of Chemical Engineering, with Dr. Rhodes as Director, was organized as one of the four schools in the College of Engineering, and was given authority over the curriculum leading to the degree Bachelor of Chemical Engineering. In 1946 a separate curriculum leading to the degree Bachelor of Metallurgical Engineering was established and the name of the school was changed to the School of Chemical and Metallurgical Engineering.

In 1941 the Herbert Fisk Johnson Professorship of Industrial Chemistry was endowed, and Dr. Rhodes was awarded the great honor of being appointed the first holder of this Professorship.

Professor Rhodes is the author of over fifty articles on scientific and technical subjects, and books on "Technical Report Writing," and "Elements of Patent Law." He is a director of the General Aniline and Film Corporation, a member of the American Chemical Society, the AIChemE, and the American Society for Engineering Education. He holds membership in Phi Beta Kappa, Sigma Xi, Tau Beta Pi, and Phi Kappa Phi. He also belongs to the Tourbillon Club of Quebec, disappearing every summer into the Laurentian forests to emerge just before registration day with some pretty tall tales of the woods and streams. Information is current that he is a charter member of the Tompkins County Literary and Inside Straight Society, but no records exist as to the charter of the society, nor is it on the list of University approved organizations, and nothing is known as to its worthy purposes and significant objectives.

Isn't Tommy LUCKY!

Tommy went to a school in the middle west, with hundreds of other bright-eyed youngsters.

One day there was a fire in Tommy's school . . . from defective electric wiring. The schoolhouse was "fireproof", but the contents weren't. So the flames spread, until the whole school was ablaze like a roaring "fireproof" furnace.

Tommy managed to get out. He was badly burned, but he was far more fortunate than some.

That fire was one of five school fires that occur each day, and will continue to occur as long as there are worn and faulty equipment and human carelessness. Regardless of whether a school is constructed of "fireproof" materials, there seems to be no sure way to prevent some fires from *starting*.

But there is a practical and absolutely dependable way to *control* fires before they do material damage.

A Grinnell Automatic Sprinkler System stops fire immediately, automatically, wherever and whenever it strikes. Seventy years' experience shows that this protection is close to 100% effective.

LOOK FOR THE GRINNELL SPRINKLER HEADS ON GUARD!

In schools, hotels, theatres, factories and hospitals there is a moral obligation upon management for the utmost in protection of life and property. For your own sake ask about it in the schools you attend, the hotels where you stop, the theatres to which you go. *Everywhere* you go, look for the famous Grinnell Sprinkler Heads —your assurance of dependable fire protection. Grinnell Company, Inc., Providence, R. I.

GRINNELL

FIRE PROTECTION SYSTEMS

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL.

Cornell Aero Lab

(*Continued from page* 19)

allow pressure to be maintained in 90 per cent of the tunnel volume while the test model is serviced or changed, and special rigging carts permit rigging of one model while another is being tested.

There are also two smaller tunnels operated by the Aerodynamic Research department, one of them a supersonic tunnel, 2½ x 7 inches, capable of producing air velocities of 1400 mph.

Some of the work in which the laboratory has been engaged is shown in the accompanying pictures. The model shop is a necessary adjunct to wind tunnel studies, which demand a high degree of accuracy in the models constructed for aerodynamic tests. Some of these models even have miniature electric motors so that the normal stresses due to the engine will be present during the tests.

In the Development Division, models which simulate the physical properties of the human head, the most vulnerable part of the body in event of a crash, are used in developing safer automobile and airplane design. The air-supported building of fiberglass cloth is also a product of this department.

Other work is carried on in the large altitude chamber capable of simulating altitudes of 70,000 feet, with temperatures of —85 degrees Fahrenheit. The Materials department has made a study of structural laminates consisting of plastics reinforced with glass cloth; this material, only half as heavy as aluminum, is strong enough for use in a variety of aircraft structural parts.

The function of the Laboratory as an educational institute is well served by the fellowships bearing the names and sponsorship of the aircraft companies that originally sponsored the Laboratory. The interchange of Laboratory staff and University faculty and the summer employment of graduate students have forwarded both education and research. The Cornell Aeronautical Laboratory is well described as "an instrument of service to the aircraft industry, to education, and to the public at large."

Vari-Type

(*Continued from page* 28)

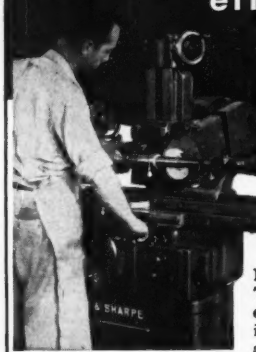
minutes in the linotype system. Thus, for a big city newspaper, with deadlines to meet, and train schedules to maintain, the procedure is too unwieldy and slow.

Considering this alternate system, so quickly put into use and so well perfected despite its inherent shortcomings, it seems to be good. For a small-town, one-edition paper, whose news need not be up-to-the-minute, its merit is indisputable. Not only does it require machinery and equipment less expensive than that now in use, but its operation, together with a smaller amortization of machinery cost, is lower. It may not be that the third great invention since Gutenberg's movable type has come upon the scene, but a major step in the direction of good-looking, yet inexpensive jobs, with a minimum of expensive machinery, has been taken. Advertisers, offices, house publications, schools, and job printing shops now have a new publishing medium.

for higher operating efficiency . . .

NEW DESIGN No. 13

Universal and Tool Grinding Machine



This general-purpose No. 13 Universal and Tool Grinding Machine embodies many outstanding refinements in design and construction for toolroom operations—grinding small and medium-sized cylindrical work, form grinding, sharpening milling cutters, reamers and similar tools and miscellaneous other types of work.

For complete specifications and description of the New Design No. 13, write Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

CHECK THESE IMPROVEMENTS

- √ Improved wheel spindle and Headstock
- √ 6 table speeds from 7¾" to 100" a minute
- √ New "bumping control knob for table adjustment
- √ 4 changes of work speed
- √ Automatic lubrication
- √ Built-in electrical controls

BROWN & SHARPE BS

"One of The Great Clothing Stores of The State"

The SPORT SHOP

CLOTHING FURNISHINGS

ITHACA

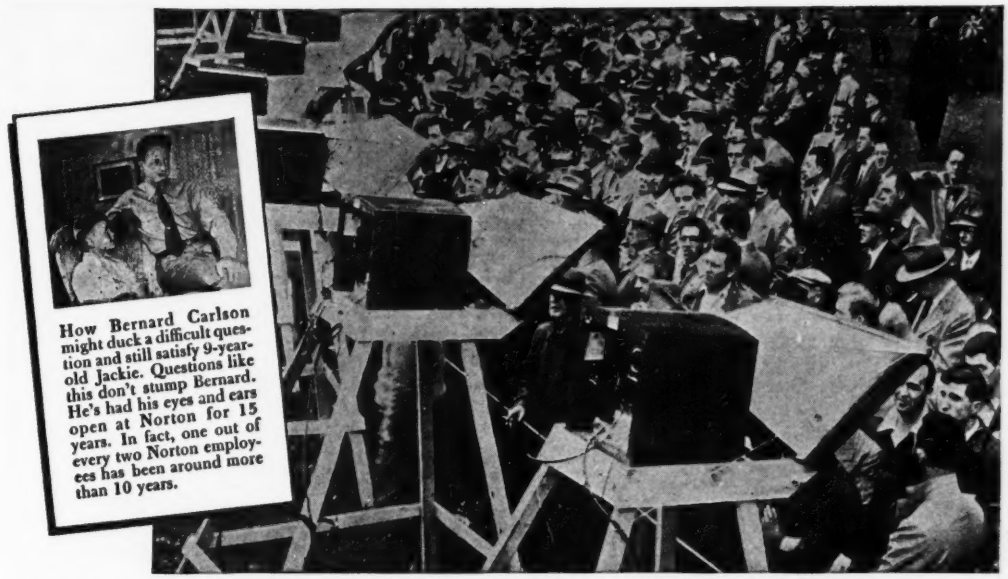
4-2555 Phones 4-2111

TWO GOOD PLACES TO EAT

The Home Dairy Cafeteria

and

Home



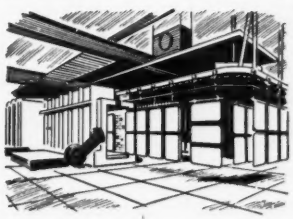
How Bernard Carlson might duck a difficult question and still satisfy 9-year-old Jackie. Questions like this don't stump Bernard. He's had his eyes and ears open at Norton for 15 years. In fact, one out of every two Norton employees has been around more than 10 years.

News photo of crowds watching television on Boston Common.

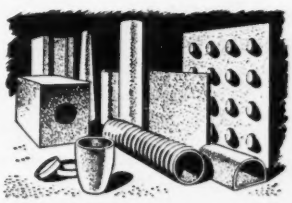
BUT, DAD, WHAT MAKES TELEVISION SO CLEAR?

"Lots of things, Jackie! But mostly brains. The brains of men who know how to make electrons behave in tubes. Electrons are tiny particles of electricity. They're boiled out of metal wires by heating units. Much the same way as an electric stove boils water. But if the heating unit isn't right, everything goes wrong."

"The tube people are smart, son. They make sure the heating units give off the right heat and last longer by coating them with a fine Norton refractory. Alundum 38900 grain, we call it. It's so fine that ten grains end to end equal the thickness of a piece of paper.



'Alundum refractory grain is great stuff. Its melting point is 2015°C. That's real hot! Made into corrugated baffle plates, it doubles the efficiency of enameling ovens. That's why the surfaces of such things as refrigerators and electric stoves come so hard and smooth.



"Some people know Norton only as the world's largest maker of grinding wheels and machines, Jackie. But refractories in many sizes, shapes and materials are important Norton products, too. They're used in kilns, furnaces and ovens whenever industry wants to get the most out of high temperatures... safely."

"So, you see, son, from television tubes to refrigerators, Norton Products help make all kinds of products better. That's why the experienced heads and willing hands that make up the Norton team try a little harder to make Norton products better."

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH

GRINDING AND LAPPING MACHINES · LABELING MACHINES · NON-SLIP FLOORING

REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NORBIDE PRODUCTS

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

BEHR-MANNING, TROY, N. Y. IS A DIVISION OF NORTON COMPANY

LAVA

Manufacturers of Super-Refractories Only

•

REFRACTORY CRUCIBLES
GRAPHITE CRUCIBLES
HIGH-TEMPERATURE CEMENTS
SPECIAL REFRACTORY BRICK, TILE, SHAPES

•

From the Following Materials:—

GRAPHITE SILICON CARBIDE FUSED ALUMINA MULLITE
MAGNESIA ZIRCON

•

LAVA CRUCIBLE COMPANY of PITTSBURGH

Pittsburgh, Pennsylvania

School Directors

Electrical Engineering

(*Continued from page 20*)

rows to organize a committee to coordinate all the research work in the United States on radio wave propagation to work with a similar committee in England under the Chairmanship of Sir Edward Appleton. Under the chairmanship of Dr. Burrows, this committee not only formulated the program for research on radio wave propagation for the United States and enlisted the cooperation of research laboratories in the United States, but secured the coordination of research work in England, Australia, New Zealand and Canada with the work in the United States.

Dr. Burrows has been a member of the Radio Wave Propagation Committee of the Institute of Radio Engineers since its formation in 1938 and currently is Chairman. He is president of the Joint Commission on Radio-Meteorology of the International Council of Scientific Unions, which had its first meeting in Stockholm in June 1948. He is president of Commission II, Tropospheric Propagation, of the International Scientific Radio Union as well as Chairman of Commission II of the U.S.A. National Committee of the same Union and is Vice Chairman of the U.S.A. National Committee of this Union.

He is a Fellow of the Institute of Radio Engineers, American Institute of Electrical Engineers and the American Physical Society and is a member of the American Astronomical Society and the American Society for Engineering Education, as well as Eta Kappa Nu, Sigma Xi, and Tau Beta Pi. He is a Past-Chairman of a Panel of the Research and Development Board and is now serving as a consultant for this Board.

Engineering Physics

(*Continued from page 21*)

During the war, Dr. Smith served as a consultant and associate director of the R.C.A. Laboratories. His invention of an electronic beam method of frequency modulation of magnetrons was rewarded with a Navy Certificate of Merit.

At present, Professor Smith is using his wide experience in research to help others. In addition to his dual position as Chairman of the Department of Physics and Director of Engineering Physics, he is a member of the Advisory Grants Committee of the Research Corporation. Dr. Smith is also serving as a consultant to R.C.A. and to the Carbon and Carbide Company.

Professor Smith was one of the originators of the engineering physics curriculum here at Cornell. During his research during the war, he and many others noticed a definite lack of men trained in the application of the discoveries made by the theoretical research, and, in general, to do industrial research and advanced engineering development. Dr. Smith has noticed an enthusiastic response from industry to this program. Very favorable answers were received from research laboratories when the curriculum was sent to them, and some have already asked to be put in touch with future graduates. So it seems as if this plan has proved to be a success.

"Magnet Wire? I didn't even know ROEBLING made it!..."

THIS VISIT to just one of the Roebling works has been an eye-opener. Everyone in my line knows Roebling wire rope, but I never heard that you stack up so big in electrical wires and cables."

☆ ☆ ☆

Many people are surprised to learn of the wide diversity of Roebling's line of wires and wire products. It is often news, too, that several different items in the Roebling line are used in one and the same field. In mines and quarries, for example, Roebling Wire Rope, Aggregate Screens and Portable Electrical Cable are all likely to be on the job together. Wherever there's industry, there are Roebling products that help bring highest efficiency and lowest service cost.

WOVEN WIRE FABRIC. Roebling weaves wire screens to meet every sort of industrial requirement. From large size Aggregate Screens to closely woven Filter Cloths, wires made of special steels and non-ferrous metals bring new measures of resistance to abrasion and corrosion.

WIRE ROPE. Roebling wire rope is made in a complete range of types and always affords a rope that's *right* for every application. For easy handling, smooth operation and long life on the job, Roebling Preformed "Blue Center" Wire Rope is unsurpassed.

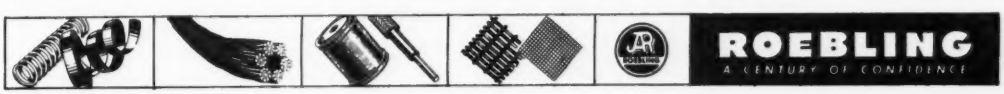
ELECTRICAL WIRE — CABLE — MAGNET WIRE. With more than 60 standard types, Roebling's line of electrical wire and cable meets practically all transmission, distribution and service needs . . . The insulation of Roevar Magnet Wire is 10 to 40 times tougher than other types — first choice for high-speed winding.

ROUND—FLAT—SHAPED WIRE. Manufacturers adopt Roebling high carbon wire for its dependable uniformity which minimizes machine stoppages and rejects, and pulls down production costs.

☆ ☆ ☆

Whatever career you are studying for, when you get on the job you will find one or more types of Roebling products serving there, dependably and at low cost. John A. Roebling's Sons Co., Trenton 2, N.J.

BRANCH OFFICES: *Atlanta,* 934 Avon Ave. ★ *Boston,* 51 Sleeper St. ★ *Chicago,* 5525 W. Roosevelt Rd. ★ *Cleveland,* 701 St. Clair Ave., N. E. ★ *Denver,* 1635 17th St. ★ *Houston,* 6216 Navigation Blvd. ★ *Los Angeles,* 216 S. Alameda St. ★ *New York,* 19 Rector St. ★ *Philadelphia,* 12 S. 12th St. ★ *Pittsburgh,* 835 W. North Ave. ★ *Portland, Ore.,* 1032 N. W. 14th Ave. ★ *San Francisco,* 1740 17th St. ★ *Seattle,* 900 First Ave. So.



Really Wool

(*Continued from page* 10)

ther guarantee that the fabric is resin-treated. Just another case of Johnny Q. Customer demanding the very best.

Applying the Resin

For shrinkage control, the most popular resins are the alkylated methylol melamines. Soluble in water at all proportions, these resins are ordinarily marketed as a heavy syrup containing about eighty per cent resin. Their application to wool basically amounts to immersing the cloth in the resin bath in open width, squeezing out the excess resin, drying the cloth, and finally curing the resin.

First, the cloth is run through the resin bath containing two per cent or more of resin dissolved in water. From there, the fabric is drawn through squeeze rolls closely adjusted to insure uniform pressure and thus uniform wet pickup. After two passes through the bath and squeeze rolls, the cloth absorbs the resin to the extent of two to fifteen per cent based upon the weights of the dry resin and the dry fabric. The cloth may then be placed on a tenter frame and dried at slack tension at a temperature in the neighborhood of 230° F.

The main disadvantage of the chlorination process had been the difficulty in controlling the extent of chemical attack. Since chlorine reacts so vigorously with wool, especially when wet, inadequate control led to non-uniform treatment, if not permanent damage to the fibers. Excessive concentrations of chlorine gave the wool the coarse texture of crude homespuns. The fibers were yellowed and their tensile strength and wearing qualities reduced. However, chlorination has come a long way since its toddling infancy in the early 1900's. By now, careful process control has cleared away many of the original shortcomings.

Once dried, the resin is finally cured, preferably between 300° and 400° F, in special high-temperature equipment. The curing time for eight ounce flannel may be five minutes or longer if the temperature is 300° F. or may be only a third of a minute if the curing temperature is 400° F. During the curing step, the relatively small resin molecules link with one another to form larger chemical groups. As polymerization continues, the solubility of the resin in water and organic solvents drops practically to zero. This accounts for the stability of the cured resin regardless of laundering and dry cleaning. Curing is usually followed by a light but thorough washing to remove any soluble material remaining in the fabric.

Quite recently, the American Cyanamid Company announced the development of a vastly improved process for wool shrinkage control. Of major importance, it requires the use of no special high-temperature apparatus. Standard drying equipment has proven entirely satisfactory. The resin can be dried and cured in a single operation at standard drying temperatures below 225° C. Repeated mill trials have clearly demonstrated that the new resin process is astonishingly simple and can be applied to a wider range of fabrics than ever before—with even more precise control.

New Ideas

Realizing full well that science can never safely stand still, chemical and textile companies throughout the country have been working continually not only to improve existing processes but to originate radically new ideas for wool shrinkage control. Only in this way will industry be of increasing service to the millions of us who rely so heavily upon wool as a primary clothing material. Only in this way will science, ever growing in its usefulness, be able eventually to take the anguish out of washday.

Messrs. Kenneth H. Barnard, George L. Royer, Richard E. Sumner, and Victor E. Wellman of the American Cyanamid Company deserve special thanks for their help in the preparation of this article.

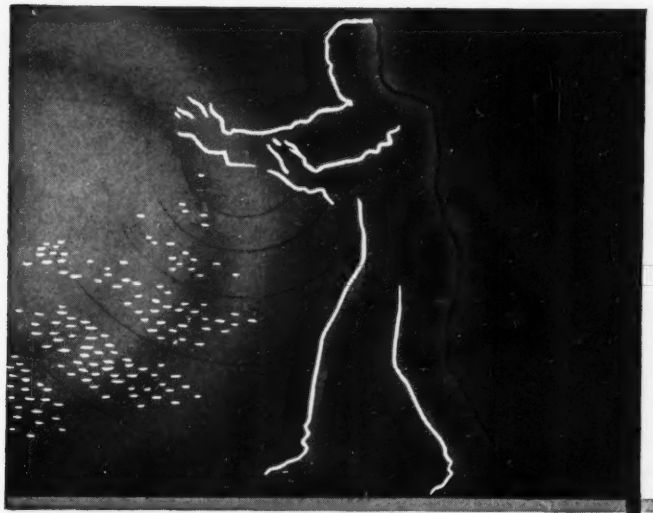
partners in creating

K & E drafting instruments, equipment and materials have been partners of leading engineers for 81 years in shaping the modern world. So extensively are these products used by successful men, it is self-evident that K & E has played a part in the completion of nearly every American engineering project of any magnitude.

KEUFFEL & ESSER CO.

EST. 1867

NEW YORK • HOBOKEN, N. J.
Chicago • St. Louis • Detroit
San Francisco • Los Angeles • Montreal



Blind man's buff

Blind man's buff is an expensive game to play with alloy steels. It is safer to go directly to the steel that will give the best performance at the lowest cost per finished part.

Molybdenum steels have shown time and again that they will provide consistently good properties at surprisingly low cost. Even their impact strength is consistent because they are not temper brittle.

Send for our comprehensive 400-page book, free; "MOLYBDENUM: STEELS, IRONS, ALLOYS."

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

CA

Cranberry Storage at Sandwich on Cape Cod, Massachusetts

CRANBERRY GROWERS LIKE
Frick Refrigeration

And have used it over thirty years!

Frick equipment serves this industry in three ways: for short term storage at 32°F; for long-term storage at –5°F; and for freezing the berries to be made into juices—thus carrying the rich color of the skin throughout the liquid.

Freezer for Cranberries at Barnstable, Mass.

The three cranberry plants on Cape Cod use seven big Frick refrigerating machines.

Frick Compressors in Cranberry Plant at Chatham, Massachusetts

The Frick Graduate Training Course in Refrigeration and Air Conditioning, Operated Over 30 Years, Offers a Career in a Growing Industry.

FRICK CO.
WAYNESBORO PENNA. U.S.A.
Also Builders of Power Farming and Sawmill Machinery

PUZZLE OF THE MONTH

CE's have their troubles. Out at surveying camp, one man had a chain of sixty-three links. For some strange reason, known only to devotees of the transit, he wanted to convert it into a collection of segments and cut links from which he could withdraw any number of links (cut, joined, or otherwise) from one to sixty-three inclusive. What is the minimum number of cuts he could make in the chain to make this possible?

▼

Answer to last month's puzzle:

90 chickens
9 pigs
1 cow

College News

(*Continued from page* 15)

used as a booster on an axial-flow compressor for a gas turbine. A small experimental machine, shown in the accompanying photograph, was built at the Aeronautical Engineering school, and it was run and measurements were taken to check the theoretical predictions for its operation. The theory of low-pressure sound waves does not apply very well to the problem, since it is desired to obtain pressure rises of several atmospheres, and the disturbances take the form of shock waves, which show very steep pressure gradients, and which are encountered in high-speed aircraft and in explosions.

The machine used in the tests at Cornell is a compressor, and thus not intended to deliver shaft power. It consists of a rotor, about four inches in diameter and six inches long, containing a series of tubes parallel to its axis and arranged around its periphery. Hot gases from a combustion chamber are fed into the tubes along a short arc at one end; this propagates shock waves in the air in the tubes, and these are collected as compressed air by an outlet located on the other end of the rotor. The rest of the revolution is concerned with removing the exhaust gases from the tubes and filling them with fresh air to repeat the cycle. Some of the compressed air produced is fed back to supply the combustion chamber, and the rest is available for use. Design of wave machines is carried out through a mathematical approach called the method of characteristics.

There is a close analogy between the development of heat engines and the progress of man's use of electricity. The first known electrical phenomena were electrostatic, as were the first electrical machines, and from these early things man progressed to using direct current equipment and finally to alternating current machinery, which is now most widely used. On the other hand, the first heat engines, the steam and reciprocating internal combustion engines, are really hydrostatic machines, since they depend on confining individual batches of the operating fluid in a vessel. For many applications, a great improvement in efficiency and compactness was achieved by the introduction of steady flow machinery, such as the steam turbine and gas turbine. It seems not at all unreasonable that in the near future an "alternating current" type of heat engine will come into use. In fact the wave engine shows good promise for medium and small size units, where friction is a great drawback in flow machines. It can be used in smaller diameters, meaning smaller wheel periphery speeds, and is thus inherently more rugged than the flow type of gas turbine.

Cornell Research

Cornell University's research program has almost doubled since 1946 and now has a value of $9,000,000

(*Continued on page* 42)

DOW

CAUSTIC SODA

All American!

TAKE THIS FOOTBALL PLAYER.
From head to toe Caustic Soda is part of his equipment. The plastic in his helmet, the fabric of his jersey and trousers, the leather in his pads and shoes—in the processing of all these, Caustic Soda plays an important part. Back in the locker room, his soap, towels, the trainer's surgical cotton and dressings, all are made with the help of Caustic Soda.

Caustic Soda is truly an All American—the workhorse of the processing industries. Virtually everything we see or touch in our daily living makes use of this chemical.

The Dow Chemical Company is one of the major producers of high quality Caustic Soda. Large plants in Midland, Michigan; Freeport, Texas and Pittsburgh, California are devoted to producing this important chemical. It is transported to industry everywhere in Dow's fleet of specially designed tank cars. Yet for all its importance, Caustic Soda is only one of over 500 essential chemicals produced by Dow—"Chemicals Indispensable To Industry and Agriculture."

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

DOW
CHEMICALS INDISPENSABLE
TO INDUSTRY AND AGRICULTURE

Cosmic Rays

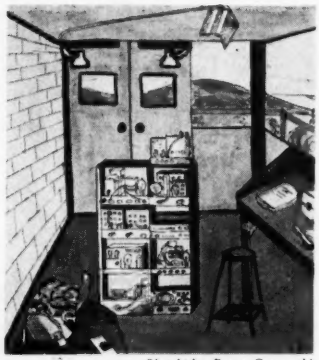
(*Continued from page 7*)

can only be observed above 70,000 feet altitude, and thus can only be studied with balloon and rocket experiments. These particles are heavy nuclei that have been stripped of all their electrons and somehow accelerated to high energy in outer space. Indeed, the primary cosmic rays are now known rather positively to consist of nuclei of all elements, in approximately the same relative abundance as that of the elements in stars—by far the most abundant element being hydrogen. The heavier nuclei, on account of their great charge, lose energy much more rapidly in our atmosphere and seldom penetrate more than ⅛ of it. At a given latitude, the nuclei of a given weight are roughly monoenergetic, because below a certain energy they are kept out by the earth's magnetic field, while at higher energies the abundance rapidly falls off. The lower energy limit can be varied by changing the latitude. Thus, by balloon flights at various latitudes one may study nuclear interactions of many kinds of nuclei having variable energies of order of magnitude 10^{11} electron volts. Such study has been undertaken by Professors Bradt and Peters of the University of Rochester.

If one goes down into a deep mine, one enriches the beam in a different kind of way. All the particles that interact strongly with matter are absorbed in the ground, as well as all the weakly interacting particles of low energy, while the mesons of extremely high energy are not much reduced in number. One finds then a weak beam that (probably) consists only of ultra-high-energy mesons and the electrons they produce nearby in the earth. By study of the behavior of this beam, one may find out about the interactions with matter of mesons that have average energies as high as 10^{11} to 10^{12} electron volts.

It is clear that the machines of nuclear physics can not in the near future duplicate or surpass the conditions afforded by cosmic rays for some studies of high energy particles as are suggested above. Precision type experiments on these particles in cosmic rays are only in their infancy. Therefore we expect to have many more enjoyable years of pursuing the more interesting particles around our planet.

During the last few summers, our cosmic-ray group at Cornell has migrated to the Mt. Evans region of Colorado, where the Inter-University High Altitude Laboratories (of which Cornell is a member) has constructed modest laboratory and living facilities. During the summer of 1948, Cornell had 6 graduate students and 3 staff members at these mountain laboratories—a total of 19 persons counting wives and children. Last summer we had 3 graduate students and the same 3 staff members,‡ with a total of 13 persons. These expeditions were made possible by generous grants from the Research Corporation.



—Sketch by Renee Greenwald

The roof-deck Cosmic-ray laboratory at the Floyd Newman Laboratory of Nuclear Studies here at Cornell.

For the experiments on high energy mesons, we too have sought locations underground, as shown in Fig. 3. This is not very far underground, but the sandstone above the tunnel is equivalent in weight to twice the earth's atmosphere, and acted as a sufficiently effective filter for these experiments.

Figure 4 shows a much deeper location, more than 2,000 feet underground in the Cayuga Rock Salt Company mines, located in Myers, a few miles north of Ithaca. This company, its president Mr. Bolton, and its engineer Mr. Whitman, have been of great service in giving us help and facilities to work at such a depth, which is under the equivalent of about 150 atmospheres. The mesons that penetrate here are expected to have an average energy of about 5×10^{11} ev. The apparatus shown in the picture was constructed by Lowell Bollinger, a Physics Department graduate student who hopes to discover whether the particles really are high-energy mesons as we expect, and some of their properties.

Lowell Bollinger with Geiger counters and circuits in the Cayuga Rock Salt Co. mines, at Meyers, New York, 2250 feet below ground.

—Courtesy Cornell Photo Science Service,

Sol Goldberg

‡ The author, Prof. G. Cocconi and Dr. V. Cocconi-Tongiorgi.

THE CASE OF THE

Expanding Spandrel

Night and day, winter and summer, year after year, for more than twenty-six years aluminum spandrels (the vertical area between windows in skyscrapers) were exposed to the weather . . . and nothing happened.

That was proof enough for the architects.

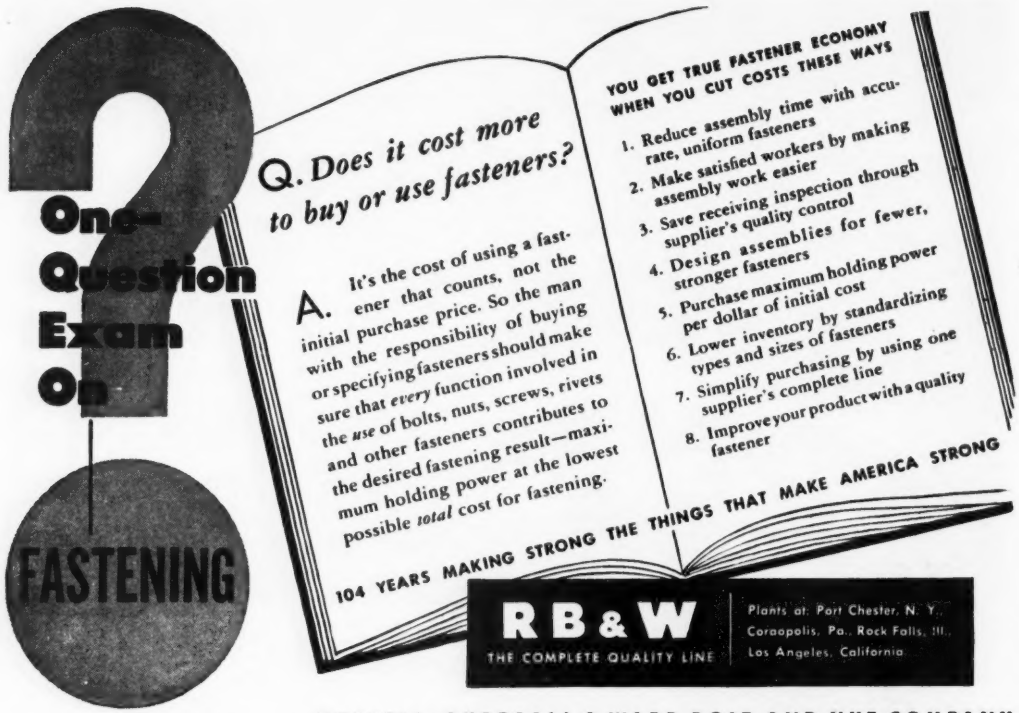
Proof that Alcoa Aluminum castings used for spandrels stood up in all kinds of weather, resisted corrosion, kept up their good appearance, never needed maintenance.

"Aluminum works so well for spandrels," reasoned the architects, "why not expand its use . . . make entire walls of it?" They came to Alcoa with their ideas. Alcoa engineers had kept pace. Designs and methods for making complete walls were ready. New ways had been found to make aluminum cheaper and more useful.

Today you will see aluminum-clad buildings going up in every part of the country. These buildings are quick and inexpensive to build. Their aluminum walls never will need expensive painting or repairs.

This case is typical of the history of Alcoa and of the men and women who work for it. While aluminum was proving itself in small applications, Alcoa engineers were perfecting the methods for large scale production and fabrication. Within the lifetime of men now living, this company has grown to be one of America's great industries. New developments now underway in Alcoa's laboratories are pointing the way to even more widespread uses for aluminum in the years ahead. ALUMINUM COMPANY OF AMERICA, Gulf Bldg., Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**


One-Question Exam On FASTENING
Q. Does it cost more to buy or use fasteners?
A. It's the cost of using a fastener that counts, not the initial purchase price. So the man with the responsibility of buying or specifying fasteners should make sure that every function involved in the use of bolts, nuts, screws, rivets and other fasteners contributes to the desired fastening result—maximum holding power at the lowest possible total cost for fastening.
YOU GET TRUE FASTENER ECONOMY WHEN YOU CUT COSTS THESE WAYS
1. Reduce assembly time with accurate, uniform fasteners
2. Make satisfied workers by making assembly work easier
3. Save receiving inspection through supplier's quality control
4. Design assemblies for fewer, stronger fasteners
5. Purchase maximum holding power per dollar of initial cost
6. Lower inventory by standardizing types and sizes of fasteners
7. Simplify purchasing by using one supplier's complete line
8. Improve your product with a quality fastener
104 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG
R B & W
THE COMPLETE QUALITY LINE
Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, California

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Use the CORNELL UNIVERSITY PLACEMENT SERVICE

Administration Building, Ithaca
John L. Munschauer '40, Director

New York Office, 107 E. 48th St.
Paul O. Reyneau '13, Manager

College News

(*Continued from page* 38)

a year, Dr. T. P. Wright, the university's vice president for research, disclosed recently.

Included in the current program are some 900 separate projects involving 1,325 persons and reflecting a 'tremendous breadth of interests and activities," the former Civil Aeronautics Administrator said in his first semi-annual report to Chancellor Edmund E. Day and the Cornell Board of Trustees. The report summarized activity at the campus at Ithaca, the Cornell Aeronautical Laboratory, Inc., at Buffalo, the Cornell Medical College in New York City and the New York State Agricultural Experiment Station at Geneva, N. Y.

Projects, partially listed in the report, extend from livestock insect control, sand research and studies of the allocation of UNRRA supplies to investigations of electromagnetic propagation in the atmosphere and the secrets of nuclear energy.

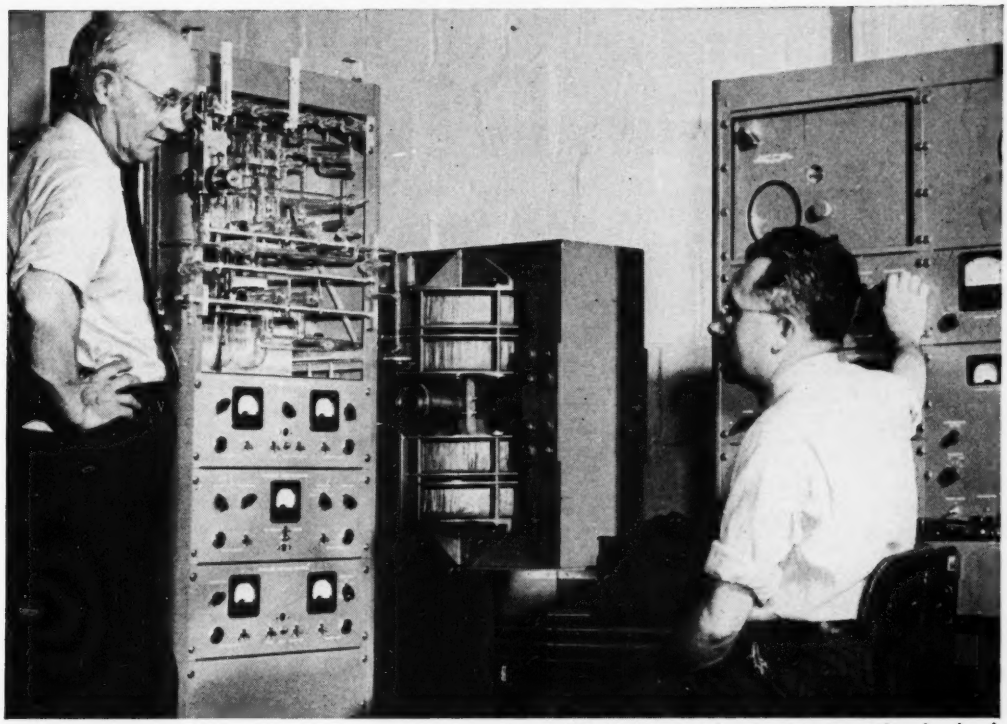
"The problem of security has been avoided at Cornell by a policy which prohibits classified research on the campus," Dr. Wright said. "The Aeronautical Laboratory in Buffalo, preponderantly and frankly classified and applied, makes it possible to perform that type of public service at a location where academic freedom is not involved."

"There are no doors at Cornell on which a sign is hung, 'No admittance—work being performed in secret'," Dr. Wright said. "A spirit of academic freedom now exists and must continue on the campus."

Woods Wins Fellowship

David F. Woods, of Ithaca, has been selected as the first winner of a graduate fellowship in engineering physics which has been established at Cornell University by the Radio Corporation of America. Worth $2500 for the year, the fellowship is renewable upon proper recommendation, and is to be used for advanced training in applied science in the field of engineering physics.

Woods, son of Mrs. D. F. Woods of Fairways, Pelham, N.Y., received his B.M.E. at Cornell in 1948 and last year was a graduate student and teaching assistant in engineering physics. Dr. L. P. Smith, who is director of the Department of Engineering Physics announced the award.



New analytical techniques with mass spectrometer, infrared and pod equipment. Refinery Chief Chemist G. Lansing, Washington & Jefferson, '11, Cincinnati '17, J. A. Simpson, N. Y. U. '38, Stevens '43.

What should a man work For?...

Put that question to either of the men shown here, and he'd answer about like this:

"Well, you could say a man works for a living, but there's more to it than just that. A man has his self-respect to keep. He wants to work at a job he likes. He wants to do something useful. He wants fair pay and steady hours—with some time to himself and his family. He wants a chance to get ahead and he wants to save some money. And he wants some security in case of accident or sickness. Then, when his working years are done, he wants to know he can retire on an annuity."

Today, in Esso Standard Oil Company, 28,000 men and women have jobs which offer exactly these things.

They have such jobs because of a company policy that was set up over 30 years ago—and developed side-by-side with our workers ever since. It is a policy based on the belief that the heart of a business is its people—that the best possible jobs attract the best possible workers.

Workers in this company today have everything outlined in the statement above—including vacations with pay, sickness benefits, cash savings in a Thrift Plan, and the opportunity to retire with income for life.

Our 28,000 workers, for instance, have now been with us on the average for 12 years—8,400 of them more than 20 years.

But this policy hasn't grown from "generosity" alone. It's a practical, common-sense *business* policy, and a good one. Because we know that the best way for Esso Standard to help meet the growing oil needs of the world is . . . by doing our best to help our workers get "the things a man works for."

Esso

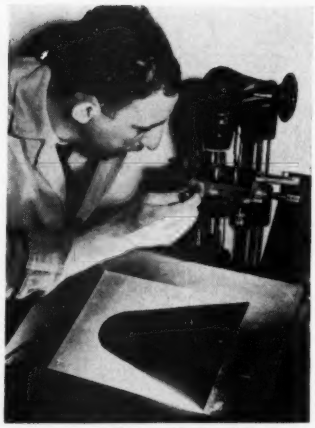
ESSO STANDARD OIL COMPANY

High Fidelity Music

(*Continued from page 12*)

The chief annoyances arising from the record itself are needle scratch and the distortion and noise arising from worn grooves. Vinylite provides a substantially quieter surface than shellac or lacquer, but the dust that is attracted electrostatically, if allowed to collect in the grooves, causes an intermittent crackle. It is essential that microgroove records be kept clean to minimize this noise and to prevent the dust from being rolled into the grooves permanently. Wiping the record before each play, or washing with soap and water when really dirty, are effective practices.

It might be mentioned that the high frequencies are usually recorded at a higher level than the low frequencies; this pre-emphasis affords a greater signal-to-noise ratio in the highs which predominate in needle scratch. Subsequently, through special equalizing circuits, the highs are reduced to the level of the medium and low frequencies, thus restoring tonal balance but decreasing the apparent scratch.



—*Courtesy The Tetrad Corporation*

Shadowgraphic inspection of stylus tip.

Another device used to minimize the extraneous noise such as needle scratch or turntable rumble that is superimposed on the desired signal—in this case music, is the noise suppressor. This is a specially designed circuit, present in some of the more expensive amplifiers, which closes an electronic gate to the momentary peak intensities characteristic of noise, but keeps the gate open to music.

In time the grooves in the records become worn, and the stylus will no longer track in exactly the same path as was originally cut. This wear is minimized by employing a low tracking pressure, using a needle of high hardness which does not easily deform, and handling the records, particularly microgroove, with care to prevent scratching. The condition of the needle is extremely important and is certainly much neglected in practice. A deformed needle will wear out the grooves much faster than a new needle of the shape for which the groove is designed. The sapphire-tip stylus, second only to diamond in hardness, has come into more general use with the advent of microgroove recordings. But by far the best is the diamond-tipped stylus, now available for ten or fifteen dollars, and probably good for well over a thousand plays.

(*Continued on page 46*)

DIAGRAMMATIC CROSS-SECTION VIEW OF A

LUFKIN Chrome Clad Steel Tape

This cross section view gives you the "inside story" of the most outstanding development in steel tapes in years. (1) Hardened steel tape—tough—flexible—kink-resistant. (2) Rust resistant coating. (3) Multiple coats of electroplating. (4) Hard, smooth, non-glare chrome plating. Will not crack, chip or peel. (5) Jet black markings—easy to read in any light—bonded to steel base—sunk below chrome surface protecting them against wear.

Ask your distributor for them or write for complete details on Lufkin Chrome Clad "Super Hi-Way," "Pioneer," and "Michigan" Chain Tapes.

THE LUFKIN RULE CO.
SAGINAW, MICHIGAN
PRECISION TOOLS — TAPES — RULES

EASY TO READ MARKINGS THAT ARE DURABLE

CHRISTMAS CARD TIME AGAIN!

We're ready to supply your needs from our huge stock of regular Christmas cards or our exclusive Cornell views. Drop in and make your selection while our stock is at its best.

24 HOUR IMPRINTING SERVICE

SPECIAL PRICES ON QUANTITY ORDERS

10% TRADE DIVIDEND TOO

Use your dividends to buy your Christmas cards and gifts at the Co-op or . . . buy your Christmas cards and gifts at the Co-op and collect more dividends.

THE CORNELL CO-OP

Barnes Hall On The Campus

BUILD the basic machines of an industrial world!

by CARL MALMBERG
Superintendent, Tank and Plate Shop
ALLIS-CHALMERS MANUFACTURING CO.
WEST ALLIS WORKS
(Graduate Training Course—1930)

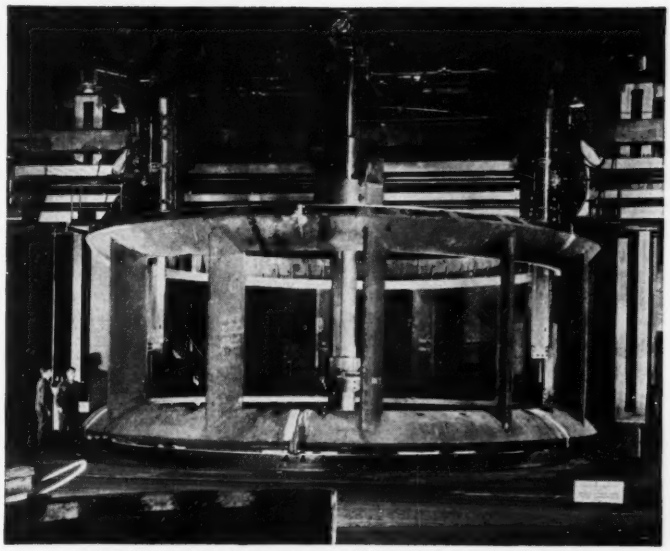
PRODUCTION METHODS have become a good deal more technical and complicated in the last few years. There is a big difference between the way we do things now and the way we did them when I left the Allis-Chalmers Graduate Training Course to work in the machine shop in 1930. That is why there are more and more opportunities in the manufacturing end of the business for young engineers who get a thrill from watching a project grow from a roll of blueprints to a big electric power installation or machinerv for a giant processing plant.

CARL MALMBERG

Close Coordination

In my section of the shop we specialize in fabricating machines and parts from sheet and plate steel. We work closely with the design engineers to develop the most economical way of producing their designs and we do much designing on our own. We work closely with every other manufacturing department, because more and more Allis-Chalmers products are being designed to replace cast members with welded members, and in my work we do the welding for the whole plant.

Welding stator yoke on 38,889 kva hydraulic turbine-driven generator.



Machining speed ring for a 55,000 hp turbine on a 40' boring mill, one of the largest in the country. Many A-C machines and methods are unique because of the tremendous size of work pieces and wide variety of operations required in building the world's greatest range of industrial equipment.

One recent interesting project was the fabrication of stainless steel buckets for impulse-type hydraulic turbines to replace the old cast-type buckets. Working with design engineers and hydraulic engineers, our tank and plate specialists developed a design and method of manufacturing that produced buckets with several times the life of the old type.

Opportunities Everywhere

New developments in every department mean almost endless opportunities for young engineers. Right now, the erection shop is building a big crusher for processing taconite in the Mesabi range, and we are supplying most of the other ore processing equipment for this gigantic plant, too. At our Norwood plant, engineers have completely rebuilt the production system on motors and small pumps for greater efficiency and lower costs.

In fact, here at Allis-Chalmers there are big opportunities for young engineers in all phases of engineering work—design, research and development, manufacturing, sales and erection—in nearly any industry you can name. For Allis-Chalmers builds primary equipment for electric power . . . mining and ore processing . . . pulp and wood products . . . flour milling . . . steel . . . agriculture . . . public works . . . for *every* basic industry.

The thing that influenced me most when I left the University of Illinois to join Allis-Chalmers, was the tremendous breadth of opportunity. Some of my friends from that GTC class of 1930 are sales engineers now, some are design engineers, some have traveled around the world with erection crews. I chose manufacturing because I like to see things take shape before my eyes. I tried a good many things before I made my choice and my choice has been good.

Write for details of the Allis-Chalmers Graduate Training Course—requirements, salary, advantages. Representatives may visit your school. Watch for date.

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

ALLIS-CHALMERS

High Fidelity Music

(*Continued from page* 44)

Other less noticeable difficulties are also encountered in the record. As the groove radius decreases toward the center of the record, the tracking speed may decline to a point where distortion results from too close spacing of the high frequency modulations in the groove. An especially wide "zig" in the groove corresponding to a loud note, may come too close to an adjacent groove, deforming the latter, or less frequently throwing the needle out of the groove. In addition the turntable must be of such quality that it turns at constant speed in order to avoid wavering of the pitch, commonly referred to as "wow." These details may seem petty; and yet, in the interests of high fidelity, these sources of distortion and extraneous noise must be avoided.

The power rating of the amplifier must be considerably higher than the actual power requirement, since the per cent distortion increases rapidly with the fraction of maximum power used. However there are many high-fidelity amplifiers on the market which have practically indiscernible distortion when only a fraction of their maximum power output is used. Since 0.5 watt is

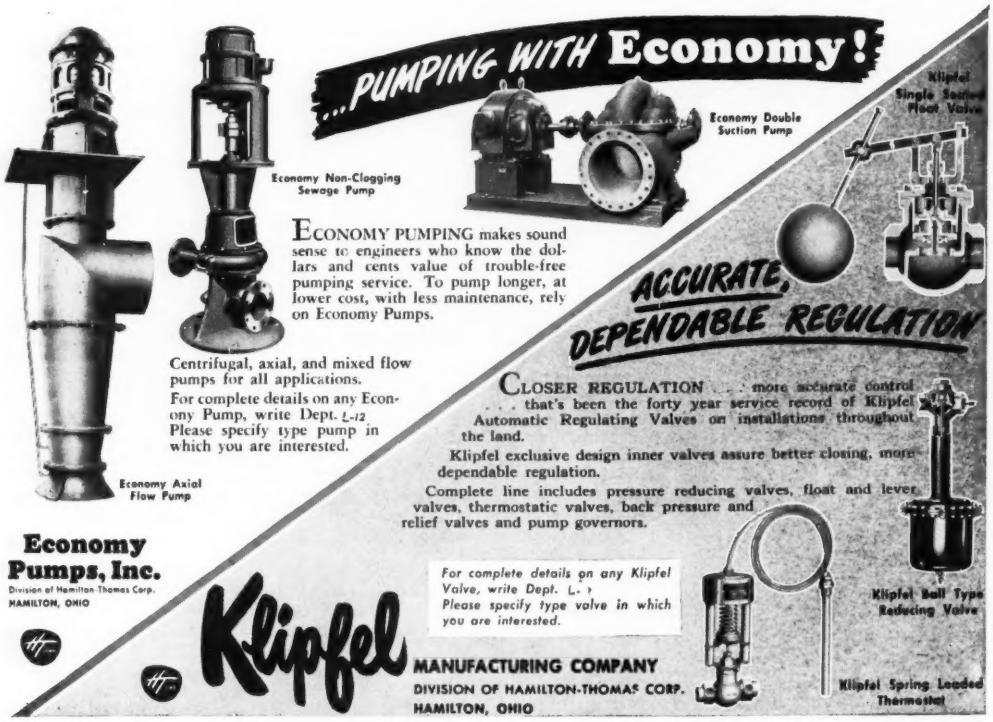
sufficient acoustic power for home use, a speaker ten per cent efficient in converting electrical to acoustical energy requires a five-watt output from the amplifier. However, the average acoustic power level is only five milliwatts so that a ten-watt amplifier would seldom be using more than a small fraction of its power.

Special precautions must be taken to reduce hum to a minimum. Preferably the power supply is on a separate chassis away from the amplifying tubes. The geometry of the circuit, power filtering, shielding, and grounding technique play important parts in hum reduction, but these ordinarily concern only those who choose to build their own amplifiers.

The amplifier and speaker, and the ouput transformer coupling them, should have essentially level response over the range of frequencies to be reproduced; that is, each frequency should be amplified to the same extent. High-quality phonograph equipment is usually rated as having level response within plus or minus so many decibels over a specified frequency range.

A correct impedance match between the output stage of the amplifier and the speaker is essential to efficiency of power transfer. The output transformer should be selected for this characteristic as well as for level response and low harmonic distortion. These transformers are expensive, but a high-fidelity amplifier is scarcely justified without an equally good output transformer.

(*Continued on page* 48)


...PUMPING WITH Economy!
Economy Double Suction Pump
Economy Non-Clogging Sewage Pump
Economy Axial Flow Pump
ECONOMY PUMPING makes sound sense to engineers who know the dollars and cents value of trouble-free pumping service. To pump longer, at lower cost, with less maintenance, rely on Economy Pumps.
Centrifugal, axial, and mixed flow pumps for all applications.
For complete details on any Economy Pump, write Dept. L-12
Please specify type pump in which you are interested.
Economy Pumps, Inc.
Division of Hamilton-Thomas Corp.
HAMILTON, OHIO
ACCURATE, DEPENDABLE REGULATION
Klipfel Single Seated Float Valve
CLOSER REGULATION . . . more accurate control . . . that's been the forty year service record of Klipfel Automatic Regulating Valves on installations throughout the land.
Klipfel exclusive design inner valves assure better closing, more dependable regulation.
Complete line includes pressure reducing valves, float and lever valves, thermostatic valves, back pressure and relief valves and pump governors.
Klipfel Ball Type Reducing Valve
For complete details on any Klipfel Valve, write Dept. L-?
Please specify type valve in which you are interested.
Klipfel
MANUFACTURING COMPANY
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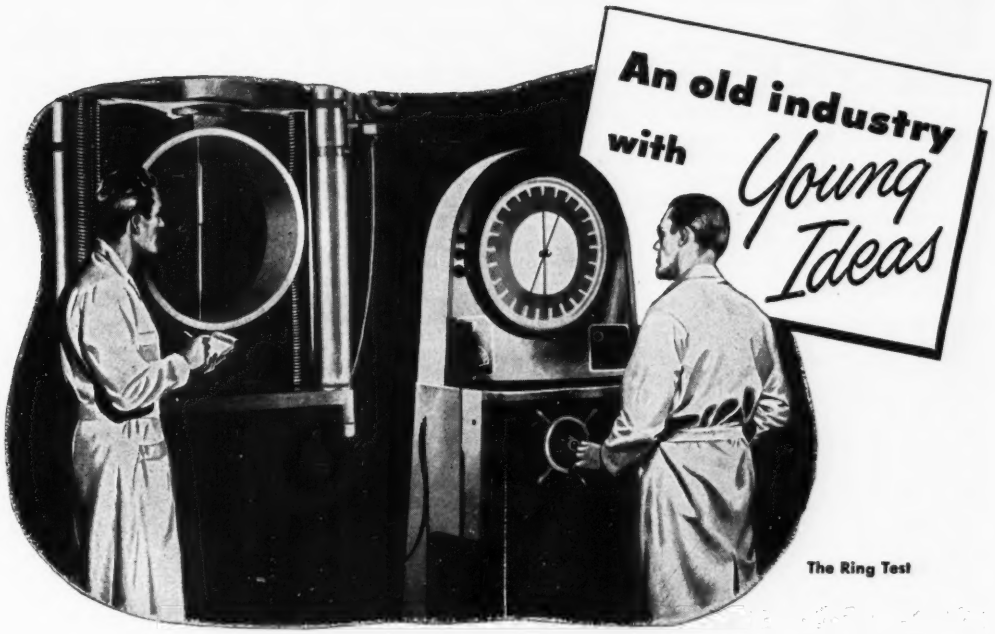
HAMILTON, OHIO
Klipfel Spring Loaded Thermostat



The Ring Test

The ring test, shown above, is a scientific method for determining the modulus of rupture of pipe. It is not a required acceptance test but one of the additional tests made by cast iron pipe manufacturers to ensure that the quality of the pipe meets or exceeds standard specifications.

A ring, cut from random pipe, is subjected to progressively increased crushing load until failure occurs. Standard 6-inch cast iron pipe, for example, withstands a crushing weight of more than 14,000 lbs. *per foot.* Such pipe meets severe service requirements with an ample margin of safety.

Scientific progress in the laboratories of our members has resulted in higher attainable standards of quality in the production processes. By metallurgical controls and tests of materials, cast iron pipe is produced today with precise knowledge of the physical characteristics of the iron before it is poured into the mold. Constant control of cupola operation is maintained by metal analysis. Rigid tests of the finished product, both acceptance tests and routine tests, complete the quality control cycle. But with all the remarkable improvements in cast iron pipe production, we do not forget the achievements of the early pipe founders as evidenced by the photograph below of cast iron pipe installed in 1664 to supply the town and fountains of Versailles, France and still in service. Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.

Section of 285-year-old cast iron water main still serving the town and fountains of Versailles, France.

CAST IRON PIPE SERVES FOR CENTURIES

FACTS ABOUT SKF

The Self-Aligning Bearing Was Invented In 1907!

Back in 1907, SKF invented the self-aligning ball bearing—the bearing that revolutionized industry by compensating for shaft deflections, distortions or weave. In 1920, SKF also invented the spherical roller bearing that has the characteristics of the self-aligning ball bearing, but is designed to absorb much heavier loads. 6595

SKF INDUSTRIES, INC., PHILA. 32, PA.

SKF
BALL & ROLLER BEARINGS

High Fidelity Music

(Continued from page 46)

The speaker and its cabinet, or baffle, are probably the most neglected components in the average phonograph; nevertheless, they too require careful design. A large speaker, of fifteen-inch diameter or more, is usually required to produce the low frequencies efficiently. Such a speaker is preferably completely enclosed (the infinite baffle) in a thick-walled, acoustically-insulated cabinet of special proportions. This enclosure prevents out-of-phase interference by providing for energy to be transferred to the air only from the front of the speaker diaphragm, and not from the back of the diaphragm or from the cabinet walls. Smaller speakers which are less efficient in converting low frequencies to acoustic energy than they are in converting higher frequencies, may be mounted in a bass-reflex cabinet, having an auxiliary opening. This vent acts as a secondary source of low frequency energy which originates from the back of the speaker. The sound from the back of the speaker is 180 degrees out of phase, but through proper dimensioning of the cabinet and vent, phase inversion is accomplished and the sound appears at the vent in phase with the sound from the front of the speaker diaphragm. Hence, the bass-reflex cabinet affords a bass boost, making the response of the speaker more nearly level, or somewhat emphasized in the bass. Insulation on at least one of each pair of parallel surfaces inside the cabinet prevents resonances and absorbs high-frequency energy so that it does not also appear at the vent. For greater efficiency dual speakers may be used, with a dividing network that directs low frequencies to a large speaker, especially designed to handle them, and the highs to a small one — aptly named the "woofer" and "tweeter."

Of particular importance to listening pleasure is the absence of transient distortion. This type of distortion occurs when the speaker diaphragm continues to oscillate after the electric signal which drives it has ceased. The usual cause is a loud bass note, and the effect is a muddiness or lack of resolution of successive notes. Good transient response is obtained through critical damping of the speaker diaphragm. This in turn is a function of the air load which the diaphragm drives and is determined by the cabinet and room characteristics. It is also a function of the electrical loading of the voice coil in the speaker as determined by the design of the amplifier.

The wide diversity in phonograph equipment, recording techniques, and the condition of the record surface make it desirable that the listener be able to change the tonal balance to meet his acoustic requirements and taste. This personal preference, rather than any arbitrarily-defined high fidelity, is really what we are striving for, taking a humanistic approach. In fact, neither the symphony orchestra nor any of its

(Concluded on page 50)

THE DU PONT DIGEST
FOR STUDENTS OF SCIENCE AND ENGINEERING

CARBON MONOXIDE... FRIEND OF MAN

Thanks to high-pressure synthesis, it now leads a useful life

To the man on the street, carbon monoxide is just a poisonous gas that sometimes causes tragic deaths when it escapes from the exhaust of an automobile or from a poorly tended furnace.

Outside of the chemical field, few people are aware that, properly used, it is a very real friend of man. In the last 25 years, during which catalytic and high-pressure chemical techniques have been highly developed, carbon monoxide has become a keystone of industrial synthesis.

A. H. Emery, Jr., *M.S. Ch.E., M.I.T. '49 and M. J. Roedel, Ph.D. Org., Michigan '40 inspecting a high-pressure batch reactor taken from the shaker tube assembly after a run to make 3,5,5-trimethylhexanol.*

Scientists have found that under the proper conditions of high pressure and temperature, carbon monoxide, in combination with other substances, can be converted to a variety of useful products. These or their derivatives range from an acid used in tanning hides to the sparkling plastics in milady's boudoir.

You'd hardly associate carbon monoxide with anti-freeze. But at temperatures from 300 to 450°C. and under pressures of 1500 to 15,000 pounds per square inch, carbon monoxide and hydrogen unite to form methanol—a colorless liquid from which is made "Zerone" anti-rust anti-freeze for automobiles. From methanol and carbon monoxide as raw materials, ethylene glycol for "Zerex" anti-freeze is produced.

Plastics and Anti-Freeze

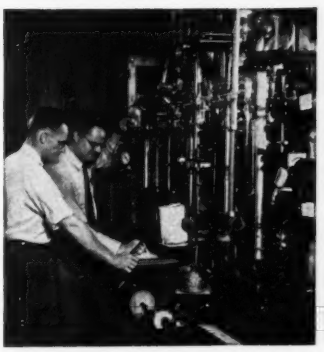
Methanol is used also to make a large number of compounds such as formaldehyde and methyl methacrylate. The former goes into urea- and phenol-formaldehyde plastics for light fixtures, radio cabinets, hardware, utensils, and electrical equipment. The latter is the basic material for "Lucite" acrylic resin with its many uses.

R. L. Stearns, *B.S. Ch.E., Yale '49 and H. Peterson, B.S. Ch.E., Northeastern Univ. '42 checking a multi-stage carbon monoxide compressor used in semi-works operations.*

The reaction of methanol with carbon monoxide leads to acetic acid, which is a well-known industrial chemical. By the same synthesis but substituting ethanol for methanol, propionic acid is obtained. From it come the "Mycoban" sodium and calcium propionates that retard mold and rope in bakery products.

Synthesis in the Future

Today Du Pont manufactures some 120 different items that are partly or wholly dependent upon elevated pressures. However, the possibilities have by no means been exhausted. Just recently, for example, chemists have been learning how to use carbon monoxide in "up-grading" certain petroleum hydrocarbons to give interesting alcohols. One of these, 3,5,5-trimethylhexanol, is prepared from diisobutylene by reaction with carbon monoxide and hydrogen.



A. J. Hill, Jr., *Ph.D. Org., Yale '44 and F. F. Holub, Ph.D. Org., Duke '49 carrying out an experiment on a new method for purifying carbon monoxide. The large furnace in this apparatus operates at 1200°C.*

College-trained men and women interested in working in this field at Du Pont may share in discoveries as outstanding as any yet achieved.

Because of the wide scope of Du Pont's activities, young graduates in many different fields have opportunities to select the careers that prove to suit them best as their abilities and interests develop.

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Entertaining, Informative—Listen to "Cavalcade of America" Tuesday Nights, NBC Coast to Coast

High Fidelity Music

(*Continued from page* 48)

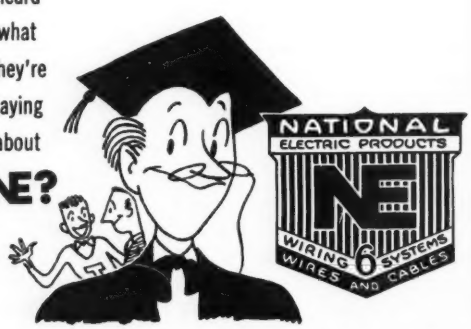
instruments need be considered an ideal source of music. Some eager mathematician, obsessed with the beauty and order of numbers, might decide that the spectral distribution curve should ideally be parabolic, and subsequently doctor his recorded music electronically to conform to this ideal. Of such stuff has human progress often been made. To provide the listener with a means of changing the tonal balance when his conception of high fidelity vacillates, a flexible tone control is practically a must. The tone control should allow either boost or attenuation of either bass or treble separately. Probably there's more psychological value than anything else in the tone control, but individualism demands it.

High fidelity, then, because of individual differences, is not simply performance characterized by a set frequency range. Rather it must be defined with respect to the listener. A *high fidelity* phonograph is one which will reproduce in recorded music at least the same undistorted range of frequencies with the same relative intensities as the particular listener hears directly from the orchestra. On the other hand, a *good* phonograph is one which will reproduce recorded music to the listener's taste; though probably relatively free from distortion and noise, its music output might conceivably bear little resemblance to that of a high-fidelity phonograph. And if it boasts a flexible tone control, it might serve as either a *good* or a *high-fidelity* phonograph for several people. Many music lovers will boost the bass and attenuate the treble, choosing to sit closer to the cellos than to the oboes or cymbals; this is not high fidelity in a strict sense, and yet representing what the listener wants to hear, it may be a sort of subjective high fidelity. It is interesting to note here that because the propagation of sound from the speaker is increasingly directional with increasing frequency, for any setting of the tone control, several people may simultaneously choose their own preferred tonal balances by sitting at the proper place in the room.

The consumer should consider what frequency range he can actually make use of before investing in high quality equipment, for the cost of recorded music rises sharply as its undistorted range of frequencies is widened. And it is of special economic importance that the various components of the phonograph be of equal quality.

If a music lover with a critical ear really wants wide-range, high-fidelity music, then he should give careful consideration to each of the details here enumerated. If he has good equipment, including a turntable, pick-up, amplifier, output transformer, and adequately-baffled speaker of high quality; if he can settle down in a quiet listening environment and place a clean record in good condition under an undeformed needle; if he has a good tone control at his fingertips to satisfy his every whim; then he can sit back and relax—he's got his high fidelity, or whatever he wants.

Have you heard what they're saying about NE?



Some grad is spreading the word that National Electric is the world's largest single source of supply for electrical roughing-in materials. (And he couldn't be righter!)

Since 1905 NE products have set the pace for quality. Today the NE *complete* line of electrical roughing-in materials includes: wires, cables, conduit, raceways and fittings.

National Electric
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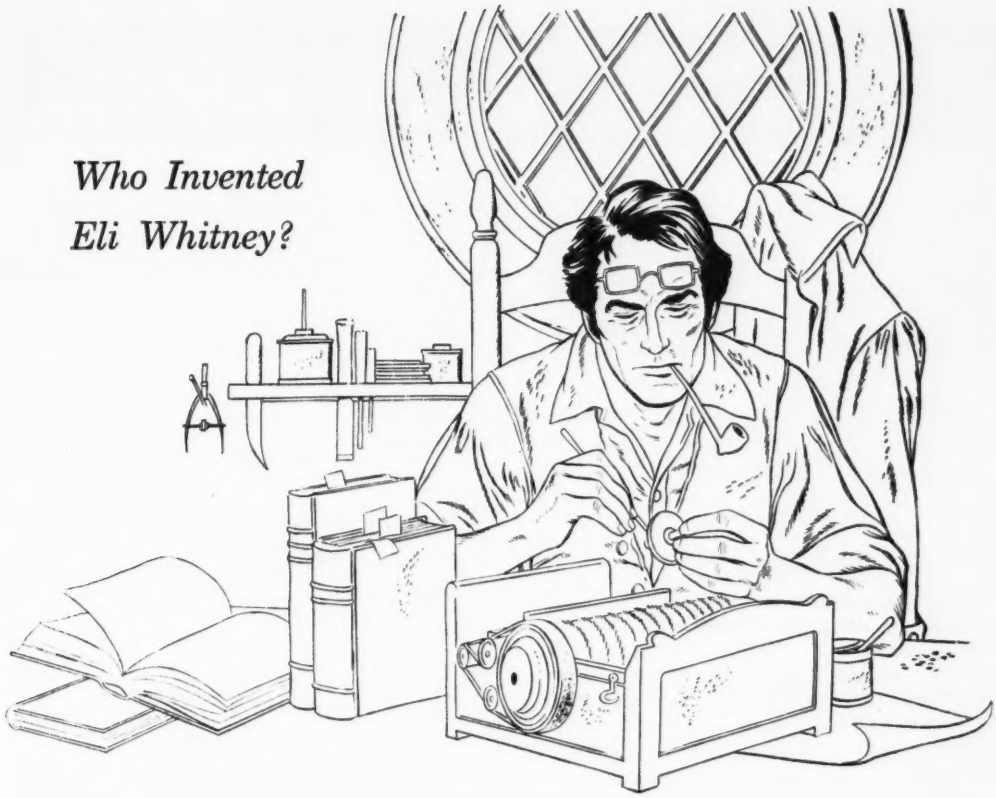
317 E. State St.

OUR NEW TELEPHONE NUMBER

4-1271

Who Invented Eli Whitney?



In 1793 Eli Whitney helped a growing nation take another step in the direction of greatness. Inventions like his made and keep America great. But what does the greatness of American inventors and technology prove?

It proves that Americans are better trained than other people in the scientific and technical fundamentals so necessary for the continuing progress that has kept America the world's greatest nation. In America, the finest textbooks are available to all. This is the background for the technological advances that raise one country above all others.

Many of the books from which you learn your fundamentals bear the McGraw-Hill imprint. McGraw-Hill is the world's largest publisher of books for technical reference and instruction as well as for advanced research and study.

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Today in school and tomorrow in business, you will find that your progress depends on your up-to-the-minute knowledge of your field. And, McGraw-Hill will continue to serve with books and magazines designed to provide all that is important and current.

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STRESS and STRAIN...

We've a warm spot in our hearts for the humor editor of the Widow, who headed last month's section, "the staff of this publication points with pride to the clean white space between these jokes."

• • •

Joe: "Let's cut Mechanics today."

Moe: "Can't, I need the sleep."

• • •

Ode to a Slide Rule

Women are babbling all the time,
Of dates, and drinks, and dresses,
Which wouldn't help at all when I'm
Computing strains and stresses.
My slip-stick conquers without a doubt,
Whole hosts of sines and surds,
And helps me work in peace without
An avalanche of words.
Slide rules are always accurate,
Women never so;
And though they're not affectionate
They never answer, "No!"
So with women's wanton ways,
With eyebrows, lips and curls,
My little log-log polyphase
Is worth a dozen girls.

• • •

A supersalesman is a fellow who can sell the possessor of a Phi Beta Kappa key a double-breasted suit.

• • •

Nit: "Would you like to see a model home?"

Wit: "Glad to. What time does she quit work?"

• • •

Engineers wonder why girls with streamlined figures offer the most resistance.

ME: "How did you puncture that tire?"

EE: "Ran over a milk bottle."

ME: "Didn't you see it?"

EE: "Naw, the kid had it under his coat."

• • •

Physics Prof.: Watch the blackboard as I run through it again.

* * *

CE: "Let's give the bride a shower."

EP: "Count me in—I'll bring the soap."

• • •

The father of a Harvardian was buying a fountain pen for his son's graduation gift.

"It's to be a surprise, I suppose," said the clerk.

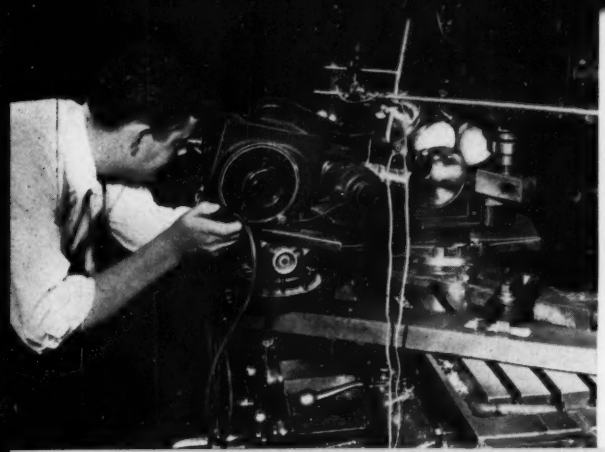
"I'll say it is," said the father, "He's expecting a convertible coupe."

God made a machine, the machine made men,
Doctors, lawyers, priests, and then
The devil got in and stripped the gears
And turned out the first batch of ENGINEERS.

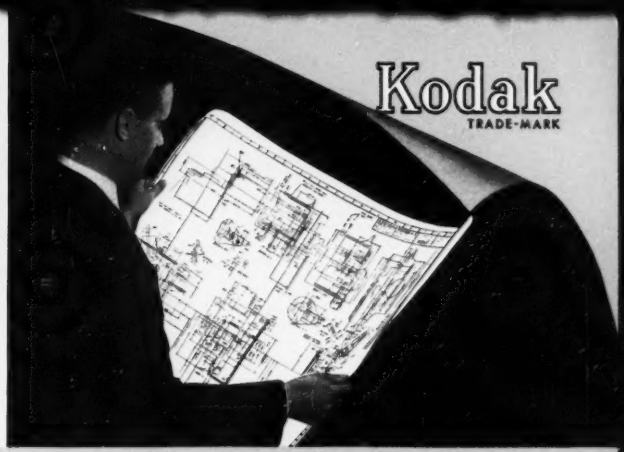
• • •

M.E. 1 Problem: A cross-eyed woodpecker with a cork leg and a synthetic rubber bill required ½ hour to peck ¼ of the distance through a cypress log 53 years old. Shingles cost 79 cents per hundred and weigh 8 ounces apiece. The log being pecked upon is 34 feet long and weighs 46 lb. per foot. Assuming that the coefficient of friction between the woodpecker's bill and the cypress log is 0.097 and that there is negligible resistance to diffusion, how many units of vitamin B_1 will the woodpecker require in pecking out enough shingles for a $7500.00 barn with detachable chicken house? The woodpecker has an efficiency of 97%, and gets time-and-a-half for overtime.

Christmas gifts . . .



IT HELPS IMPROVE PRODUCTS—High speed movies provide a record of motion far too fast to see. With the Kodak High Speed Camera, a second becomes three minutes, so you can see and analyze rapid movement—spot faulty action and points of excessive wear—see ways to make a better product.



IT COPIES DATA IN SECONDS—Engineering drawings, shop orders, specifications, records, and letters of all kinds can be copied fast, and with utmost accuracy. Photocopying with Kodagraph Papers, Cloths, and Film saves time, protects originals from wear and tear—even permits producing clean, legible copies from faded or worn material.

How photography's *Lightning Speed* works for business

HERE YOU SEE a few examples of how the speed of photography serves industry. In addition, its accuracy is used in copying drawings, documents, and data of all kinds. Its ability to reduce can put records on microfilm and save 98% of filing space.

These and the other unique qualities of photography are helping cut costs, improve products, speed production, and stimulate sales. If you would like to know more about how it could serve you, write for literature or for specific information which may be helpful to you. Eastman Kodak Company, Rochester 4, N. Y.

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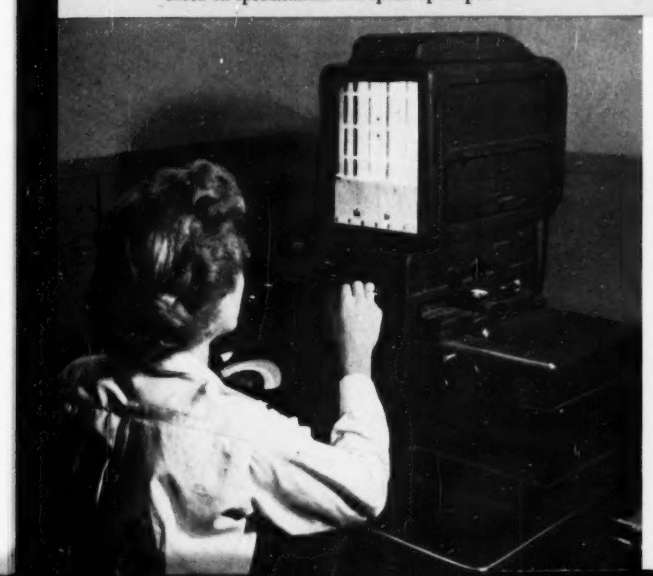
—serves industrial, commercial, scientific progress

IT ANALYZES CHEMICALS IN A FLASH—Spectrography with Kodak Spectrum Analysis Film and Plates quickly determines the composition of almost all materials. It provides a means to make frequent production-line analyses. It can maintain a check on specifications and speed up output.



IT RECORDS THE FLICK OF INSTRUMENTS—The swift swing of the galvanometer mirror or cathode-ray tube beam is not too fast for photography. Readings of these instruments are quickly recorded on Kodak Linagraph Films and Papers so that they can be studied and full advantage taken of the facts that they reveal.

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UNIQUE PLANT PRODUCES G-E SILICONES FOR INDUSTRY

On the outskirts of the little town of Waterford, N. Y. is one of the most unusual plants in the world.

New Waterford plant works night and day to produce silicones.

Where other new industrial structures may be impressive because of their physical size or tremendous productive capacity, the Waterford Works of General Electric is of interest because of the

Silicone oils are excellent mold release agents.

rare nature of the materials being produced there, and because of the new chemical processes involved in their manufacture.

Silicones from Sand

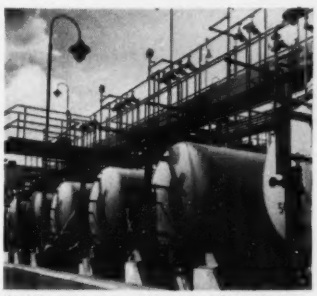
The primary raw material from which silicones are derived is sand. This basic ingredient is modified at Waterford through a complex series of pipes, tanks, stills, and reactors which are operated in a nearly automatic production system.

The most amazing property of silicones is that, like quartz, they are relatively unaffected by heat, cold, water, chemicals, and weather. But instead of being rigid, like quartz, silicones are flexible—they may take any form from liquid to solid! This flexibility permits them to be used in many

Silicone centers add new zip to U. S. Royal golf balls.

places where rigid materials with similar properties could not serve.

The finished silicone products are already being widely applied in industry, and new uses are constantly being found for them. Silicone rubber is being used for heat-resistant gaskets for aircraft and diesel engines, oven doors, and laboratory equipment. Silicone oils are excellent mold release agents for rubber and tire molders. Silicone resins promise to make possible paints and finishes of exceptional durability. Another product



Tank farm stores liquid raw materials which automatic process converts to silicones.

of G-E silicone research is called DRI-FILM*—water repellents that can be used on a variety of materials.

Put Waterford on Map

You'll be hearing a lot about G-E silicones. They're really going to put that little town of Waterford on the map.

Of course, silicones are only one of the products produced by the various divisions of the General Electric Chemical Department. It also manufactures Glyptal* alkyd resins, insulating materials, permanent magnets, plastics molding compounds, and is responsible for the plastics molding operations that have made G. E. one of the world's largest plastics manufacturers. For more information, write to the Chemical Department, General Electric Company, Pittsfield, Massachusetts.

*REG. U. S. PAT. OFF.

A message to students of chemistry and chemical engineering from

J. L. McMURPHY

Manager, Chemicals Division, G-E Chemical Department

"The new world of organo-silicon chemistry is a fascinating one—and one which promises an interesting future for a young man who wants to make chemistry his career. We at General Electric are expanding our silicone research and production to meet industry's growing need for silicones."

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